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The Forward Supply Support System–the Gulf War and Beyond

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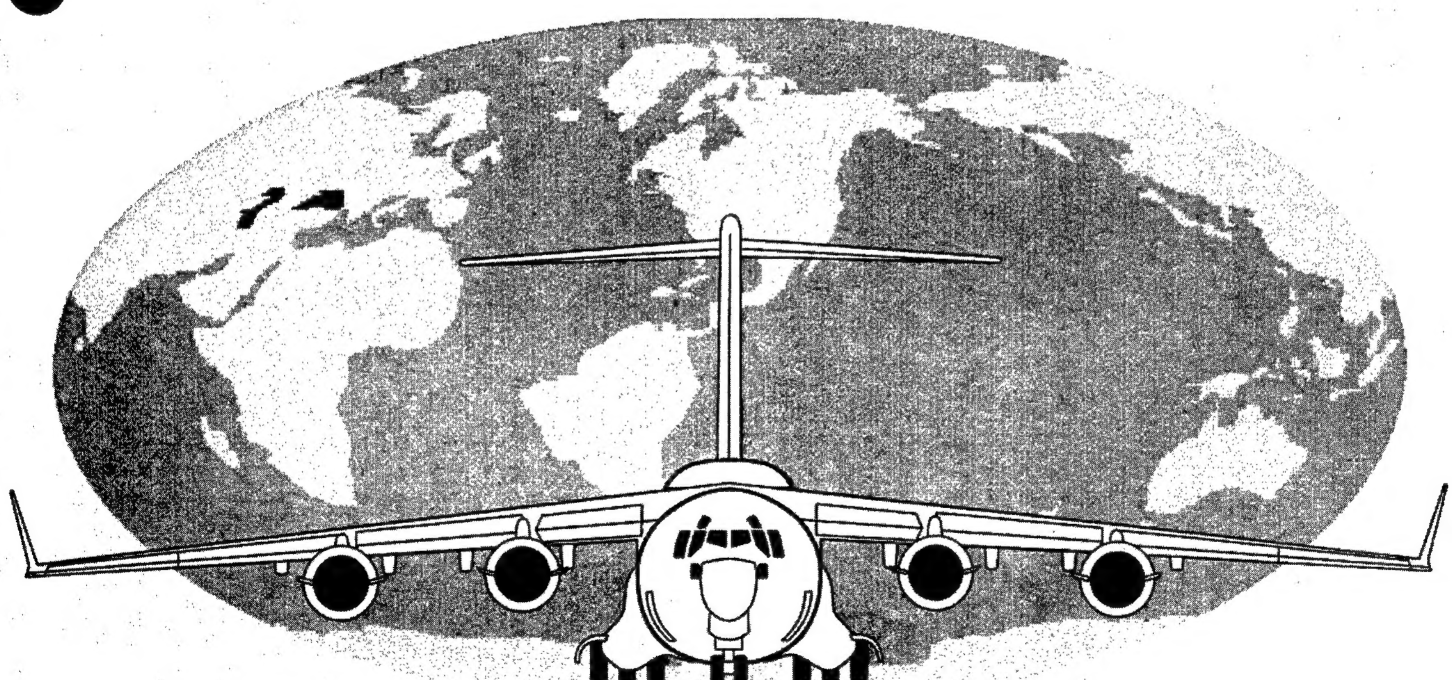

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The Forward Supply Support (FSS) System—the Gulf War and Beyond: Why the FSS System Is a Supply Success Story

John W. Schade
Colonel Thomas W. Christensen, USAF

"Tomorrow's Warriors will have to relearn the things today's Warriors have forgotten."

General Billy Minter

Overview

It is instructive that the above quotation was rescued from the editor's cutting room floor during preparation of the Gulf War Air Power Survey (GWAPS) in 1992.[1] Perhaps it was because the survey was chartered to be objective and factual, and such a quote was perceived to be unfitting. An alternative view holds that we, as an Air Force community, have never been good at remembering our mistakes and simply do not like to be reminded of that. Being pragmatic "supply types," we can attest that, from more than 60 combined years working in Air Force logistics, our record of remembering lessons learned from our mistakes is abysmal. Even worse, we have often forgotten the good stuff—the things that worked. This article describes how one of those good things worked during DESERT SHIELD/DESERT STORM, lest we forget. It further lays out a basic vision for the future that builds on a successful past.

The FSS System is not a new concept. Although its complete history will not be retraced here, there has been a variation of an FSS System for more than 40 years. This article focuses on the period July 1990 through July 1991 when the Military Airlift Command (MAC) took the USAF to war, and looks forward in time. Some of the words contained here coexist in GWAPS or were rescued from the GWAPS cutting room floor along with General Minter's quote. Mr Schade, having authored the GWAPS Supply chapter, has taken that liberty.

MAC made the peace-to-war transition in support of DESERT SHIELD/DESERT STORM without losing a step—they made it look easy. Those involved in actually making it happen will tell you it was anything but easy, but the point to remember is their hard work was related to working a system, not trying to make a system work. Not perfect by any means, but the FSS System was a showcase example of what it means *to do it the same in peace as you will in war*, and *train as you will fight*. The FSS concept endures, and with some fine tuning and technology insertion, it will support strategic airlift well into the 21st century.

Background

The FSS System is a MAC artifact. Going into DESERT SHIELD/DESERT STORM MAC operated two primary route structures—21st East, and 22nd West. The route structures constituted the primary paths followed by MAC aircraft in their day-to-day support operations. While virtually all major military installations were serviced by MAC, the route structure defined the basic support infrastructure for the MAC fleet.

The core route infrastructure included several bases that were designated for planned stops for fuel and maintenance for aircraft performing what was generally called channel airlift. These bases were also the preferred diversion bases for MAC aircraft experiencing en route problems. Each of these primary bases on the route structure was equipped to support basic launch and recovery, including refueling and flight line maintenance. The FSS System positioned spares and repair parts at these locations to support maintenance requirements. Being on the basic route, spares and specialty maintenance capabilities that were not immediately available could be quickly moved to the point-of-need via self-lift using the next available channel aircraft.

As an adjunct to the Standard Base Supply System for strategic airlift spares allocation and distribution, the physical components of the FSS System were divided into three subelements. Primary Supply Points (PSPs) were established within the Continental United States (CONUS) on the East and West Coasts collocated with the primary beddown bases for the supported aircraft. PSPs acted as regional stock control activities. Forward Supply Locations (FSLs) tailored to maintenance capability and activity levels were established at the major en route stops along the route structure. Locations on the route structure having little maintenance capability had Forward Supply Points (FSPs) containing essential spares for aircraft launch and recovery (Figure 1, following page).

During steady state operations, the consumption patterns of aircraft flying the established routes were monitored centrally at MAC, and the spares levels along the route were adjusted accordingly. These stockage requirements also drove inputs to the central buy requirements for aircraft spares. Given that strategic airlift consistently enjoyed the highest priority of all combat and combat support aircraft, the pool of spares available to support the FSS was seldom constrained by funding limitations. During the 1980s, that meant essentially 100% funding year after year. As a result, spares support for the strategic airlift fleet had few limitations going into DESERT SHIELD. The bottom line was that the C-141 and C-5 aircraft, overall, had sufficient spares to support virtually any level of operation that could be physically supported by the aircraft and the MAC crews.

The Transition to War—the FSS System Adapts

In the initial stages of DESERT SHIELD, MAC was tasked to quickly move key combat units to the area of responsibility (AOR). Concurrent with these early movements, for which the

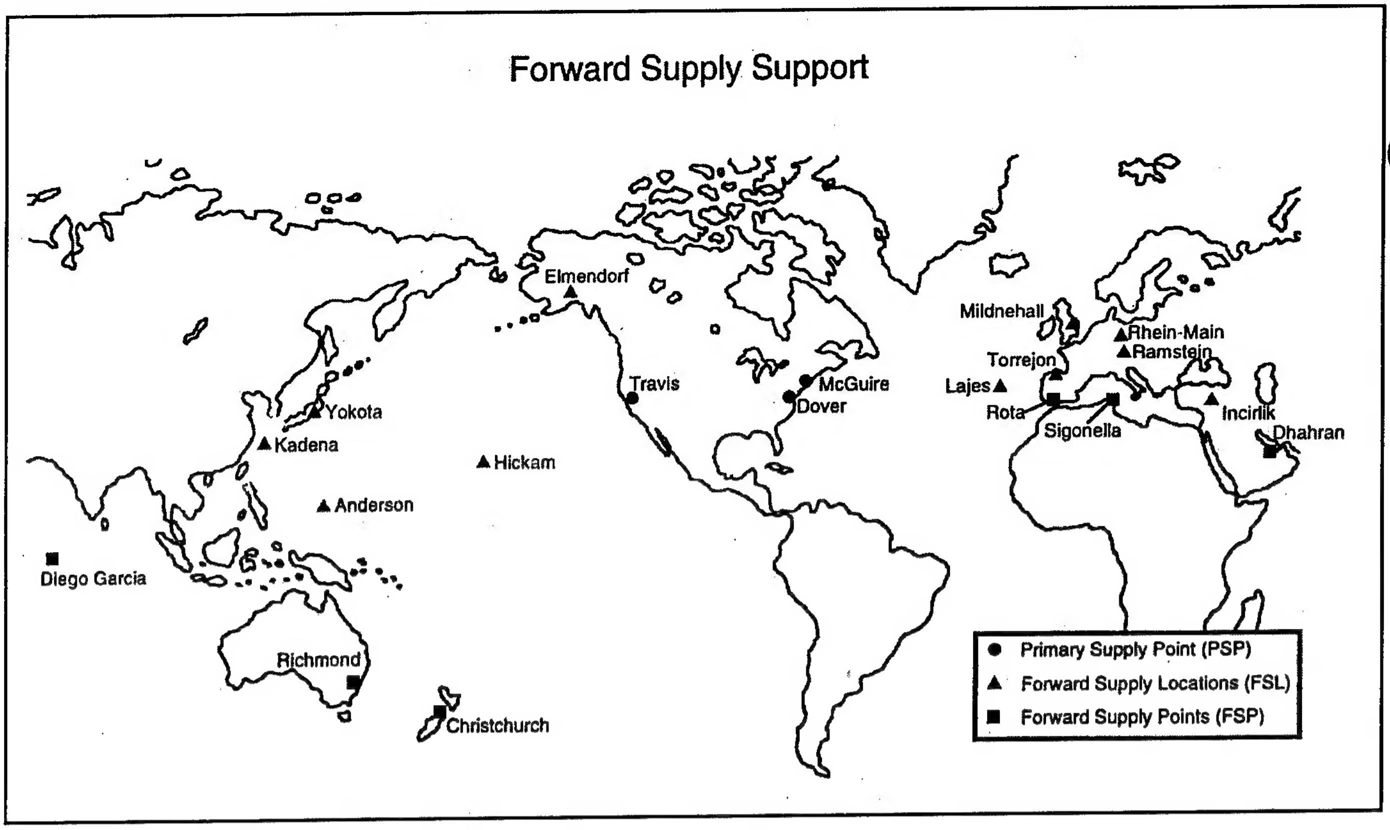

Figure 1. Military Airlift Command Forward Supply Support Route Structure

Air Force included the movement of tactical aircraft units, Headquarters MAC directed the realignment of assets along and between the route structures. In addition to the movement of in-place assets, MAC acquired significant additional assets for the system from Air Force Logistics Command (AFLC). The magnitude of these changes is shown in Table 1. Between July 1990 and January 1991, the dollar value of FSS spares increased from $76.2 million to $109.3 million, with the spares in the European segment of the system increasing from $34.5 million to $79.5 million and the Pacific segment decreasing from $41.7 million to $29.8 million.[2] Additional details on how this occurred are presented later in the article.

FSS Route	July 1990	January 1991
Europe	11.5K Units/$34.5M	18.7K Units/$79.5M
Pacific	14.0K Units/$41.7M	10.9K Units/$29.8M

Table 1. FSS Asset Shifts/Increases[3]

The Transition to War—the Standard System Breaks Down

MAC's reaction to a massive restructuring in spares consumption patterns was to reallocate available and additional spares from the wholesale system within an existing FSS structure and operate under the same basic procedures. By contrast, the major commands (MAJCOMs) dependent on the Standard Base Supply System's (SBSS's) Combat Supply System (CSS) did not do as well. Those readers interested in the details of the problems experienced by the tactical units should review the article by Colonel John Gunselman referenced in this article and the full GWAPS document. There were many reasons—some technical—but enough to say that: the CSS operating procedures were different from those used day-to-day at home station; the CSS users did not train enough with the CSS equipment and procedures to be proficient; and there were serious technical deficiencies with the CSS equipment, for instance, inadequate communications capability that had been identified but had not been fixed. Were there lessons to be learned there?

Looking at the statistics of the war, it is difficult for many people to accept the existence of problems. The performance of the Air Force was superb. But the fact that the deployed units were able to survive and prosper with the noted deficiencies of the CSS does not imply that deployed computer support or enhanced asset visibility and management capabilities were not needed. Quite the contrary, the evidence suggests the main reasons for high support levels were first, we had lots of spares in the system as a result of the high funding levels of the 80s, and second, our spares levels were based on a 30 to 60 day interruption in resupply. In fact, resupply was continuous. The interruptions experienced in supporting the AOR were primarily within and between our supply and transportation systems, not in the physical lines of communication.

Maintaining Asset Visibility

Evidence gathered during the GWAPS strongly suggests that an ability to continue automated processing of supply requirements would have greatly improved the overall efficiency of the operation and would have avoided most of the brute force heroics that were needed to keep the system running. For

example, the wholesale system lost track of war readiness spares kit (WRSK) locations.[4] As a result, nearly 80% of their redistribution orders (RDOs) were denied during DESERT SHIELD. For the same reason, the weapon system management information system (WSMIS) was all but useless during that same period. There was also much anecdotal evidence about duplicate shipments being put into the transportation system by Tactical Air Command (TAC) when they received status indicating a high priority requisition had been routed through Dover AFB, Delaware, where backlogs in shipping spares were common.

By contrast, supply operations that used preestablished or standard SBSS satellite account procedures, such as those used by the MAC FSS System and Proven Force units, did not experience the same problems as TAC. Likewise, the Central Command Air Forces (CENTAF) Supply Support Activity (CSSA), which was ultimately established for the AOR, used a more standard, although much larger, satellite account structure specifically designed to overcome the CSS problems. By its inherent design, the CSSA had total asset visibility over all assets loaded into the system. That load process, however, was slow and manual-labor intensive and, with the exception of most aircraft WRSK, visibility of the full range of supply and equipment assets in the AOR was incomplete at the end of the war.

MAC Makes the Peace to War Adjustment—More Details[5]

The primary operations supported by MAC during DESERT SHIELD/DESERT STORM were strategic airlift and tactical airlift. The strategic support was provided using C-5 and C-141 aircraft operating along the worldwide route structure shown in Figure 1. Most of the airlift support for the AOR flowed along those eastern routes that connected the CONUS and Europe with the AOR. Tactical operations used C-130 aircraft to move materiels within the AOR. The operation of the strategic routes was addressed earlier. The tactical routes were established on-the-fly to meet the day-to-day demands of forces on the ground within the AOR, moving a wide range of items and personnel from the main AOR air and sea entry points to the forward operating bases and between those locations.

As shown in Figure 1, the FSS route structure links a series of worldwide en route and turnaround stations with CONUS East Coast and West Coast hubs. Spares requirements for the overall system are computed centrally to support peak wartime tasking. Those spares are dynamically allocated to the various locations within the route structure based upon planned operating tempos and prepositioned maintenance capabilities. Although manual-labor intensive, this process has been highly successful.

To make the transition from peacetime to wartime operating tempos, MAC shifted spares and support personnel from the Pacific area of operation to the European area, which linked to a preestablished base at Dhahran, Saudi Arabia. Stock levels at Rhein Main AB and Ramstein AB, Germany, and Torrejon AB, Spain, were increased by approximately 30%, while Pacific levels were reduced by about the same percentage. C-141 WRSKs were deployed to all three of the European bases, and C-5 WRSKs were deployed to Rhein Main and Torrejon. To further augment the European route structure, MAC also redirected 425 critical assets from the Pacific Theater to the East Coast PSPs at Dover AFB and McGuire AFB, New Jersey. Also, requisitions from the Pacific Theater FSL were canceled to ensure all available spares would be available to meet East Coast requirements.[6]

Concurrently, requirements for mission-essential spares known to be in short supply were passed to AFLC. In addition to serviceable spares available in depot stock, the Air Logistics Centers (ALCs) surged their repair lines for needed items and in some cases took components off an aircraft undergoing major maintenance. Given the continued high funding of strategic airlift spares requirements in the 1980s, spares were generally available and did not constrain mission support. The impact of the MAC spares realignment and AFLC surge actions on spares within the FSS is shown in Table 1.

Demand Patterns Shift

Spares replenishment, mission capability (MICAP) requirements, and retrograde (failed components being returned for repair) were moved through the system by the aircraft operating within the route structure. The activity shifts between the Pacific and European segments of the FSS during DESERT SHIELD/DESERT STORM are clearly shown in Figure 2 on the following page, which plots the monthly requests for spares during 1990 and 1991.[7] The FSS System was able to support mission requirements throughout that period. MICAP requirements for aircraft operating within the AOR segment of the route structure were directed to the 21st Air Force at McGuire AFB. The primary supply points at McGuire AFB and Dover AFB handled FSS stock replenishment for the C-141 and C-5 respectively.

The data shown in Figure 2 were extracted from the supply data collected to support system management as a routine part of day-to-day FSS System operations. The FSS System database was subsequently used by Headquarters MAC to recompute and significantly reduce the spares requirements for the FSS System.

While the strategic airlift operations had the distinct advantage of continuing to operate on an existing route structure, the characteristics of the system are such that supply support could be easily adjusted to accommodate any additional or alternate en route bases where maintenance capabilities existed or could be established. Also, aircraft flowing back to the CONUS along the basic route structure were used to return unserviceable assets for repair at McGuire AFB (C-141) and Dover AFB (C-5). The cycle times for retrograde, repair, and return averaged 21 days for the C-141 and 19 days for the C-5.[8]

The New Air Force Supply Concept of Operations (CONOP)

Looking to the future, the working draft of the new USAF Logistics C2 CONOP recognizes the continued importance of the FSS concept.[9] The CONOP specifically recognizes the difference between the support needs of beddown forces and those of channel airlift. Specifically, while the new CONOP introduces the Air Force Contingency Supply Squadron (AFCSS), which evolved from the CENTAF Supply Support Activity, as a cornerstone of deployed supply support, it states that the FSS System will provide supply support tailored to the route structures

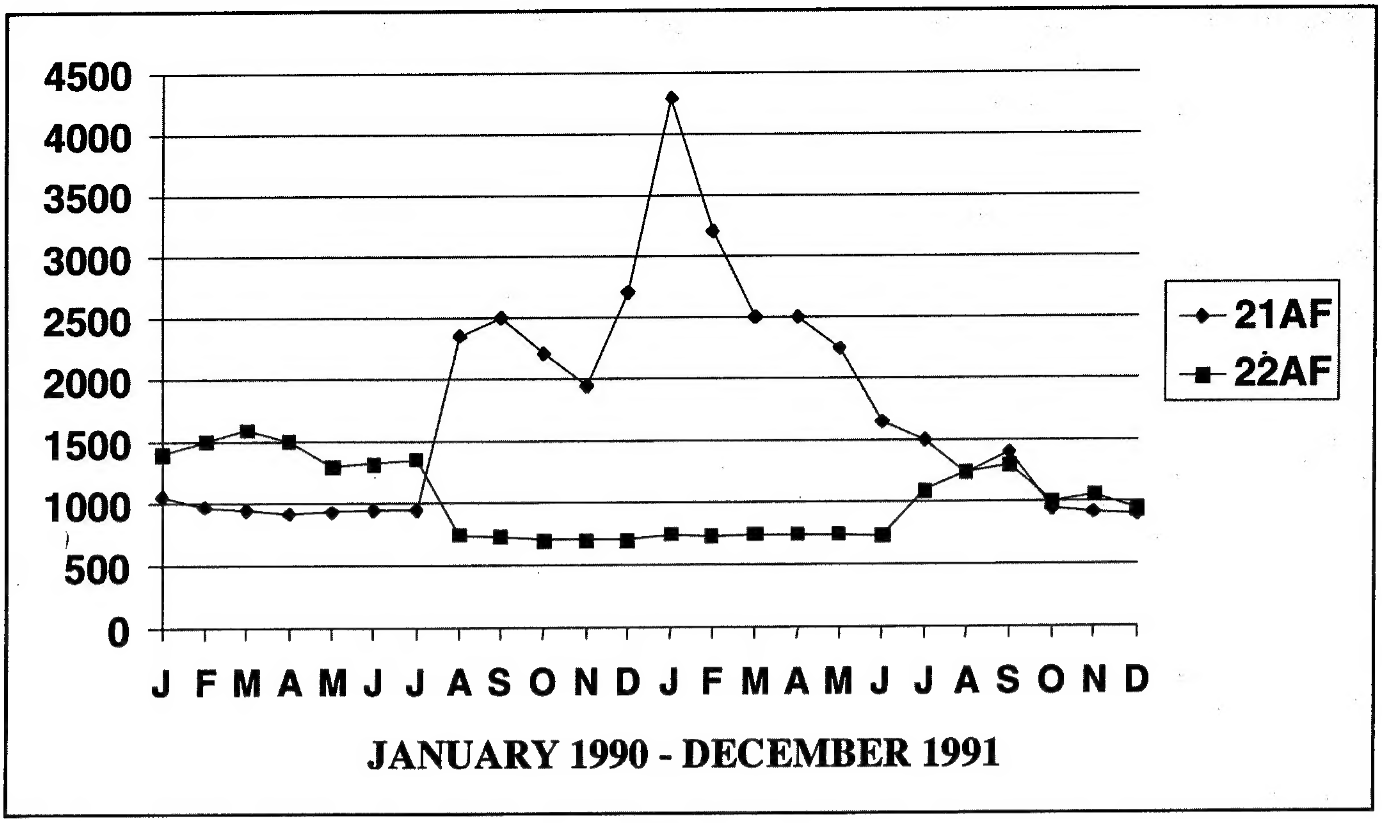

Figure 2. FSS Issue Request Chart

established to handle channel airlift. As currently envisioned, the FSS System will coexist with the emerging reach back, lean logistics, and velocity logistics concepts, and with some carefully chosen enhancements, will remain the key element of the channel airlift support for the foreseeable future.

The enhancements planned for the FSS System will build on past success. Rather than changing *what* the system will do, the focus will be on putting modern technologies to work to enhance *how* the work is performed. Great efficiencies are expected by reducing and, in some cases eliminating, routine manual data processing. Through increased automation of predefined business rules, aggressive allocation and distribution decisions can be made and implemented within hours and days, compared to the weeks and months of the past. The FSS will be transformed into a virtual en route supply system that is tightly integrated with strategic airlift operations.

Taking the FSS Concept Into the Future

Technology trends paint a picture of a golden era of rapidly expanding computer and communications tools and capabilities. We in the logistics business need to harness these new tools and capabilities in smart ways, and do it when we and the technologies are ready. Again, we must not forget our lessons of the past. Moving too quickly to unproven or "bleeding edge" technologies, adding features with insufficient pay back, or forgetting the ***keep it simple*** and ***same peace and war*** rules are recipes for failure. However, good planning and the prudent use of emerging technologies will make real the dreams of effective requirements forecasting, total asset visibility, and fully integrated systems supporting real-time support optimization. These fundamental concepts, as expanded below, provide the underpinning for a modernized FSS System capable of efficient mission support:

- Knowing what you need, and where and when you need it.
- Knowing what you have, and where it is at all times.
- Having the ability to relate capability to resources.
- Having the capability to make and implement timely allocations and distribution decisions supported by optimization algorithms.

Understanding the Requirements

Requirements determination is both art and science. Clearly we should do best dealing with historical demand-based usage. The new FSS System will maintain central visibility of all demands within the system and will support the central computation, using mission support metrics, of optimum stockage range and depth at the various types of route nodes. Standardizing stockage at like nodes across the route structure has proved to be more effective that allowing each node to level on its own demand patterns.

Uncertainty and randomness of demands, however, cannot be handled totally through stockage. Likewise, enhanced stockage concepts are not likely to materially affect the phenomenon of aircraft breaking more at the better stopover points. But, having a responsive system that will minimize the time required finding and moving assets to the point of need will minimize the impact regardless of the cause of the demand. Tight integration between the new FSS System, other Air Mobility Command (AMC) supply sources, the wholesale system, other central asset

management systems such as the Air Force Contingency Supply Squadron (AFCSS) and the AMC Tanker/Airlift Control Center (TACC), will help streamline order and ship times and will be necessary to get the desired results. Also, using AMC self-lift in moving parts within the route structure will continue to be essential and prudent.

Allocating Available Resources

Allocation is the apportionment of available resources at a point in time. Seldom if ever do we have the luxury of having sufficient resources to meet everyone's wants and needs. Allocation decisions can be very complex—multiservice, multiweapon system, multicommand, multibase, etc., others rather simple, for instance, spares that apply to only one weapon system owned by one command. Within the context of the FSS concept, the allocation issue is one of what resources can and should be made available to the system. While the FSS System does not make such decisions, having an embedded, creditable capability to relate resources to capability will allow the FSS to strongly compete for assets.

Within the FSS System, the first allocation of resource levels is between the east and west geographical areas. Allocation of resources between these entities will be a function of utilization rates and aircraft types. The second level of allocation will be among the various nodes within the individual route structures. The modernized FSS System will have a capability to optimize the allocation or apportionment of assets made available at each level.

Keeping the lessons of DESERT SHIELD in mind, as major changes in activity levels or weapon system assignments occur—or if the basic route structure needs to be changed, FSS algorithms will determine reallocation options and impacts. Given the options, leadership will be able to make timely decisions regarding the most effective and efficient way to redistribute assets in the system and where best to position new resources that may be provided from outside the system.

Putting Things in the Right Places

The distribution and redistribution of assets within the route structure will also be centrally monitored and controlled. Whereas allocation determines what you should have, distribution represents the physical movement of what you have. Effective distribution management will be one of the most important capabilities of the new FSS System. Optimization algorithms will be used to help make distribution decisions. For example, if each node is allocated four each of an item but, due to variability in supply and demand, on-hand quantities range from zero to four at the various nodes, should assets within the route structure be moved? Which assets? When? How? FSS will help make smart decisions without causing system thrashing. The FSS System of the future will proactively and dynamically optimize support to the strategic airlift mission.

Summary

The concept of "Global Reach—Global Power" and the continuing uncertainty in the world political environment dictate the continued maintenance of robust, responsive, and flexible mobility support systems. The FSS concept remains a core element of the infrastructure needed to support the channel airlift component of the air bridge concept. The FSS concept should be retained and enhanced using modern technologies to optimize the effectiveness of AMC resources and to facilitate integration with the wholesale supply systems and other central support entities such as the AFCSS. Combining total asset visibility with automated optimization algorithms supporting requirements, allocation, and distribution decisions will aid us in forecasting requirements, allocating resources, and managing distribution to best support mission needs into the 21st century.

Notes

1. Keaney, Thomas A., and Eliot A. Cohen, Gulf War Air Power Survey: Summary Report, Vols. 1 – 10, Washington DC: Government Printing Office, 1993.
2. Headquarters Mobility Air Command Forward Supply Support Database.
3. Headquarters Mobility Air Command Forward Supply Support Database, War Reserve Materiel, and Forward Supply Support Spares on hand as of date indicated.
4. When the WRSKs were deployed from their home bases, a deployment indicator was put on the supply detail records that caused the Air Force Recoverable Assembly Management System (AFRAMS) reporting to stop. Therefore, the wholesale item managers records continued to reflect asset positions, location, count, and condition "before" the WRSKs were deployed. This same problem carried over to the weapon system management information system (WSMIS) that also was seeing asset positions "before" the deployments.
5. Interview, Mr Schade with Col Robert (Dean) Rich, HQ MAC/LGS and Mr Orson Gover, HQ MAC/LGSW, 11-12 Aug 92, plus multiple Mobility Air Command data sources.
6. Reese, Ted, MSgt, USAF, "Enroute Management Actions," Point Paper, HQ MAC/LERWA, 26 Mar 91.
7. Ibid.
8. Gunselman, John H., Jr., Col, USAF, "Documentary on Desert Shield/Storm Supply Support," *Air Force Journal of Logistics* (Fall 91), p. 12.
9. Department of the Air Force, USAF Logistics C2 CONOP working draft, HQ USAF/ILXX, 30 May 97.

Mr Schade is presently a Senior Analyst with Synergy, Inc., Washington, DC. Colonel Christensen, who recently retired from the Air Force, was the Chief, Supply Division, Headquarters Air Mobility Command, Scott AFB, Illinois, when this article was written.

Environmental News

Paint Shop Provides Earth-Friendly Service

(By MSgt Tina Sims, Shaw AFB Public Affairs Office)

New technology and improved processes have made the 20th Transportation Squadron paint shop a healthier and more environmentally friendly operation. The improvements start as the vehicle enters the shop for body work and priming and doesn't end until it leaves freshly painted.

The paint shop staff has improved the way they deal with dust and paint particles, the paint they use on vehicles, and the way they clean the paint spray guns. By using a new paint mixing system, the shop eliminates paint waste and saves money by mixing only the amount of paint needed. They can mix a quart, pint, or whatever is needed.

"In addition to minimizing the paint needed, the paint used is a low VOC (volatile organic compound), which at 3.7 is lower than the 4.0 that ACC requires," said Bob Billheimer, 20th TRANS body shop supervisor. "It has high solids and gives very good coverage." According to Billheimer, it now takes a little more than a quart to paint a vehicle. With the old practices it took three or more quarts of paint, which had to be purchased by the gallon. Leftover paint was discarded.

The new system, which was tested and recommended by the Air Force through the Management Equipment Evaluation Program, comes from a dealer in Sumter [South Carolina]. It has been in use here for about six months and has been used to paint nearly 20 vehicles. The Sikkens paint mixing system allows the paint shop to match any vehicle color by using a color map.

"Vehicles are being bought right off the assembly line," said Billheimer. "We have many different colors in the fleet. To match a vehicle, we find the closest color from the color map and use grid coordinates to mix the formula for that color. We can do this with any color and don't need a paint code. We really have unlimited capabilities.

"In conjunction with the paint system, we use high-volume, low-pressure paint guns which spray with only 7 to 9 pounds of pressure coming out of the nozzle, which minimizes over-spray and gets more of the product on the job," Billheimer said.

With the old suction-feed spray gun, 45 to 65 pounds of pressure were created, which only got 25 percent of the paint on the job. The new gun gets 65 percent of the paint on the job, according to Billheimer. The new paint gun cleaning system, which uses paper towels and toilet paper to clean paint from the cleaning solvent, keeps the shop from generating waste solvent.

"We have not turned in any waste in over a year," Billheimer said. "We used to turn in 35 gallons of dirty solvent cleaner a month from the gun cleaner and we generated about 100 gallons of excess paint a year-not anymore."

Not only does the new paint gun cleaning system save solvent, it also saves time and energy. "Much less time is used. You just put the gun in and the air-powered motor, which works with dishwasher action, cleans the gun in about five minutes without brushes or scrubbing," Billheimer said.

The manufacturer recommends the paint gun cleaning solvent be changed every three years and the paper towel and toilet paper filters every six months or as needed. According to Billheimer, they have only had to add about two gallons of solvent to the system in six months due to evaporation and use.

Along with the savings realized from buying less paint and solvent, the shop uses dustless sanders and a new respiratory system, which ensure a healthier environment for workers. The dustless sander has a vacuum system connected to it, with holes in the sandpaper that match holes in the sander. As the operator sands the vehicle, paint residue and body filler are vacuumed up and contained. They never enter the environment.

"It keeps the air clean for me and makes cleanup easier," said A1C Randy Mentink, 20th TRANS body shop. "Before we had these sanders, the dust didn't stay around your project—it went everywhere." According to Billheimer, the new air supplier respiratory system is much safer for the people using it. "We use this respirator exclusively now and it is healthier for the people spraying. We can put two or three people in the paint booth now and train side by side with this system."

The paint shop has drastically reduced the amount of waste it generates and has made its workcenter healthier for those who work there as it strives to meet and exceed Air Force environmental goals.

Reprinted from *Global Environmental Outreach*, Volume 4, Issue 7, Air Combat Command and Radian Corporation, May 1997.

A Look at Cannon AFB's Growing Recycling Center

At Cannon Air Force Base (CAFB) in Clovis, New Mexico, the 27th Civil Engineer Squadron Environmental Flight has established an exemplary pollution prevention (P2) program that continues to expand. The Base has recently established a Recycling Center equipped to manage numerous municipal solid wastes. A fundamental goal of a successful solid waste reduction program is to save valuable resources by identifying and implementing alternatives to landfilling, such as innovative reuse and recycling methods. Through the new Base Recycling Center, CAFB is meeting this goal by proactively reducing the amount of municipal solid waste that must be disposed.

Ted Smith, Base Recycling Program Manager, and SMSgt Gary R. Thompson, Base Recycling Center Superintendent, have put in many hours to obtain space, manpower, and transportation for the Recycling Center. Until the facility is fully operational, the 27th Logistics Group Environmental personnel are augmenting the Environmental Flight's Recycling Center staff by assisting with some of the recycling activities.

The facility has numerous pieces of equipment that can manage a variety of solid wastes. When the Base Recycling Center is fully operational, other base organizations will be able to literally drive through the building and unload segregated wastes at different recycling stations. Each solid waste will be processed through the Base Recycling Center and sent off site for recycling. The following list summarizes the recycling stations, the solid waste(s) that will be accepted at each station, and a description of the process.

(1) The aluminum can collection point and can crusher station accepts empty aluminum cans. After the cans are crushed, they are sent off site for recycling.

(2) The fluorescent bulb crusher station accepts mercury-containing fluorescent bulbs. When the bulbs are fed into the bulb crusher, the mercury is segregated from the glass and metal wastes and collected by a filtering system. The filters, which must be changed after processing 25,000 bulbs, are collected and analyzed for mercury. The glass and metal wastes are collected in 55-gallon drums—one drum will hold between 1,000 and 1,100 crushed bulbs.

Base personnel continue to research options for reuse and recycling of the filters, glass, and metal residue. So far the most promising options include (a) segregating the aluminum bases of the bulbs from the crushed glass and recycling the aluminum and (b) pulverizing the clean crushed glass to a powder and mixing it with soil. Until these options have been fully researched, the wastes are disposed of as either hazardous or solid waste based on analytical testing results.

(3) The container crusher station accepts several types of segregated wastes: oil filters; empty, dry paint cans; and empty, depressurized aerosol cans. Each of these waste types is collected in a separate 55-gallon drum. The crusher station crushes these wastes in batch processes by waste type. For example, when enough paint cans are collected, the equipment operator will crush all of the paint cans and decontaminate the equipment before crushing the next type of waste. This process reduces the volume of the wastes before they are sent off site for recycling as scrap metal. The crusher can reduce 10 empty and dry 1-gallon paint cans to a 4" x 5" x 3" cube.

(4) The drum crusher station accepts empty 55-gallon drums, which are crushed and sent off site for recycling as scrap metal.

(5) The glass crusher station accepts glass containers, which must be segregated by color—brown, green, and clear. The glass is crushed in batch processes by color and sent off site for recycling.

(6) The bailer station accepts several types of segregated wastes including office paper; clean, corrugated cardboard with no food residuals; plastic containers (e.g., milk jugs); and newspapers. The wastes are bailed in batch processes and sent off site for recycling.

(7) The wood chipper station located outside of the building accepts landscape waste (e.g., brush). The resulting mulch is free for use for base landscaping and by base personnel for residential landscaping.

(8) Toner cartridges, compact disks, and computer disks are also accepted at the Center. These wastes are taken to Logistics personnel who coordinate with a local contractor to refurbish the toner cartridges. Currently, both types of disks are mailed by Logistics personnel to an off-site contractor for recycling.

(9) Each year, old Christmas trees are collected and used to make natural habitats for quail and other wildlife.

(10) Fiberboard boxes are collected and distributed to base personnel for use as moving boxes.

(11) Nickel-cadmium batteries are collected and returned to the original manufacturer for recycling in lieu of waste disposal.

(12) Base residents can turn in leftover latex paint which is made available as a "free issue item" to other base residents for their painting needs. Note: Base personnel ensure that paint purchased by the Government is issued for government use only.

(13) In the future, the Recycling Center staff plans to establish a composting program.

(Points of Contact: Ted Smith, Base Recycling Program Manager, Cannon AFB, DSN 681-4820 or (505) 784-4820, SMSgt Gary R. Thompson, Base Recycling Center Superintendent, Cannon AFB, DSN 681-6685/6687 or (505) 784-6685/6687)

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DTIC '97 Annual Users Meeting and Training Conference

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Inventory Reduction: When Is Enough Enough?

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Introduction

Private-sector experience in reducing inventory, mostly from just-in-time inventory control, has influenced Congress and the Office of the Secretary of Defense (OSD) to encourage the military Services to reduce their inventories. There are certainly benefits to having a smaller inventory, and most would agree that new inventory should be as lean as possible. However, the value of disposing of on-hand assets to reach arbitrary inventory reduction targets is less clear. This article will discuss some of the areas where further analysis of the costs and benefits of inventory reduction is needed.

Background

In 1990, as part of the Defense Management Report Decision 987 (DMRD 987), OSD, with input from the Services, began setting Service-specific inventory reduction goals. (3) OSD built those goals on the assumption that, after the Reagan military buildup, the inventory the Services held in 1990 was "right-sized," in the sense that it ought to be adequate to meet their operational needs. Inventory reduction goals were developed by assuming that, as the military downsized, the reduction in inventory should be proportional to the reduction in force structure. In the Air Force's case, inventory reduction goals are based on the proportion of projected flying hours to the flying hours in the base year, 1990. The inventory goals also take into account additional reductions from management improvements and the consumable item transfer program.

Figure 1 shows the OSD inventory reduction goals (in constant 1995 dollars) for 1992 through 2003 (the original set of goals went through 2001). In 1992, the Air Force's inventory goal for total secondary-item inventory was nearly $42 billion. By 1996, the inventory goal had been reduced to $30 billion. (1) The Air Force's initial estimates of its 1996 inventory value suggested that it could fall as much as $2 billion short of its goal. The Air Force may find it equally difficult to meet future inventory goals. In the seven years between 1996 and 2003, the Air Force is supposed to reduce its inventory value by another $11 billion. By 2003, roughly a decade after DMRD 987, the value of the Air Force inventory is supposed to be half of what it was in 1992.

Those are serious cuts in the value of the inventory. What happens if the Air Force does not meet the goals?

The General Accounting Office (GAO) has produced a number of reports criticizing all the Services for not reducing their spare parts inventories fast enough. In the past, the GAO has testified before Congress that the Services' spares budgets should be cut in order to induce the Services to reduce their inventories.

Indeed, OSD has cut the Air Force's obligational authority for spare parts in the past and is prepared to do so in the future. OSD's reason for cutting the spares budget seems to be that if

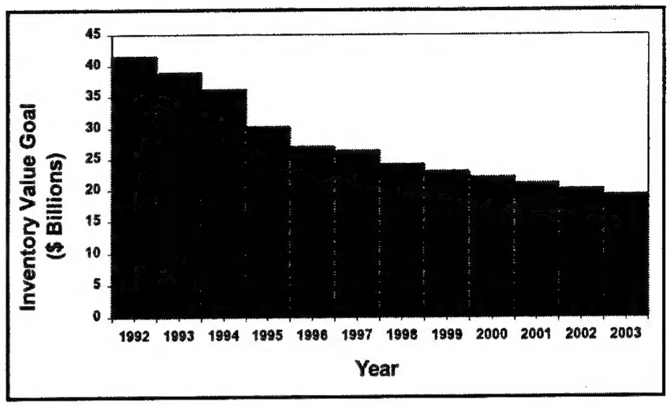

Figure 1. Inventory Reduction Goals (Fiscal Year 1995 Dollars)

the Service is not meeting its inventory reduction goal, it is either buying too many new parts or buying the wrong parts. There is little recognition of the fact that reparable parts bought in the past, although under different world threat assumptions, still have value. Since the Air Force has many parts bought during the Cold War, keeping those parts in the inventory can prevent the Air Force from meeting its inventory goals. Not meeting the inventory goals can in turn cause the Air Force to have decreased spares funding for new parts, leading to inadequate support for new weapon systems. The inventory goals can present the Air Force with the dilemma of choosing between throwing away old parts that may be still be useful or not supporting its newer weapon systems.

Air Force Inventory Reduction Initiatives

If it is done intelligently, there are benefits to reducing inventory. One way the Air Force is trying to reduce its inventory is by decreasing its requirement for spare parts and consequently reducing new buys. The Air Force's main initiative to lessen its spares requirement is its Lean Logistics program. The Lean Logistics program is attempting to make the Air Force supply system more responsive by reducing repair flow times and production lead-times. The goal of the Lean Logistics program is to change the supply system from relying on more parts to relying on speed of response.

The Air Force has also disposed of inventory already on hand. Since 1990, the start of the inventory reduction plan (DMRD 987), the Air Force's reparable inventory has dropped from over ten million units to under five million units. (5) To further reduce on-hand inventory in the smartest possible way, the Air Force currently is reviewing and revising its retention policy. For instance, the Air Staff has recently advised the Air Force Materiel Command (AFMC) to eliminate retention (above peacetime and wartime requirements) of insurance and numerical stockage items (items with virtually no demand history). The Logistics Management

Institute (LMI) is working with the Air Force to identify changes in retention policy that are based upon economic considerations.

Obstacles to Meeting the Inventory Goals

One problem with the way the inventory reduction goals are set is that not all inventory requirements decrease in direct proportion to flying hours. Safety level does not decline in direct proportion to flying hours. Wartime requirements certainly do not decrease in direct proportion to peacetime flying hours. Nondemand-based additive requirements, by their very nature, have little relationship to flying hours. Undoubtedly, the size of some of those requirements could be reduced, but expecting a proportional decline with flying hours is unrealistic.

The Air Force's ability to meet its inventory reduction goals is hampered also by the way inventory is valued. The Supply System Inventory Report values inventory as follows:

- Serviceable items at last acquisition cost (LAC).
- Unserviceable items at LAC minus repair cost.
- Potential DoD excess at salvage price (two to three percent of LAC).

The problem with using the last acquisition cost to value inventory is that an item's entire inventory is revalued every time a unit is purchased. For example, suppose the Air Force has 95 ammunition handlers, each bought for $40,000, with a total value of $3.8 million. If the Air Force buys five more at $42,000 each, for a total of $210,000, the value of the entire inventory immediately and automatically increases to $4.2 million. The increased inventory value would be nearly double the value of the new procurement. Valuing the entire inventory at LAC makes the value of the inventory increase much more quickly than does the number of units being added to the inventory. Of course, such a valuation scheme is contrary to what private industry uses, where old inventory depreciates.

Another reason why the Air Force has difficulty meeting its inventory reduction goal is the inflation allowed. When the inventory reduction goals are calculated, the value of the inventory is allowed to increase by the operations and maintenance (O&M) inflation rate—currently running between two and three percent per year. Yet, aircraft reparables have been increasing in value at a much faster rate. The asset-weighted average value of a reparable spare has been increasing at an annual rate of between six and seven percent since 1994. That increase is explained partly by the revaluation described above and partly by the more sophisticated (and more costly) nature of new parts.

Arbitrary decisions about how to value inventory can force the Air Force to dispose of older items in order to meet inventory reduction goals, even though there may be a high risk of needing to repurchase those items later. There is no economic justification for requiring disposal of on-hand inventory in order to be able to purchase complex parts for new weapon systems that Congress has authorized.

Benefits and Costs of Inventory Reduction

Minimizing Buys

What benefits accrue from reducing inventory? When the Air Force minimizes new buys, clearly it saves money. The Air Force also spends money more effectively because buying less reduces the likelihood that something bought will not be needed in the future.

Minimizing new buys does not come without risk. Mission readiness does depend on an adequate supply of spare parts. As the number of units of spare parts the Air Force owns decreases, the probability of not being able to fly the peacetime training program and have readiness spares packages (RSPs) ready for deployment increases. A shortage of spares, a problem in peacetime, could be disastrous in wartime.

Spare parts can experience unstable demand patterns. In a recent study that examined demand histories for Defense Logistics Agency (DLA) managed items applied to weapon systems, LMI found that parts with historically low demands can suddenly experience high demands. (4) In the study, LMI calculated the expected quarterly demand rate from actual demands over a two-year period. Using the demand rates calculated from these actual demand data, we calculated six years' worth of supply for each item. Then we looked at the next six years of actual demand history and determined how long it would take to deplete the six years' worth of supply. Figure 2 shows that while not all items used up their entire stock in six years, many items used up "six years' worth of stock" in much less time. Indeed, 28% of the items depleted their stock within three years.

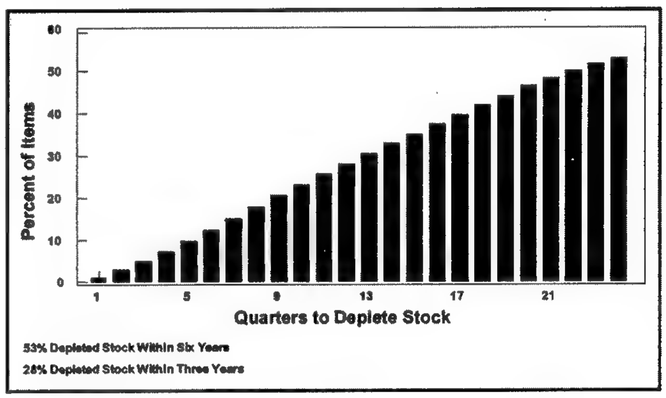

Figure 2. Time to Deplete Six Years of Forecasted Demand

Therefore, we see that buying minimal stock can lead to unexpected stock depletion that could adversely affect mission capability. Unfortunately, the Air Force cannot rely on manufacturers to deliver many of its specialized parts "just-in-time" to replace unexpected failures. Calculating the cost of the risk to mission readiness is much harder than calculating the savings from reduced spending on spare parts. However, to truly evaluate the benefit of inventory reduction, readiness costs must be included.

Reducing Storage Costs

Another benefit of reduced inventory is lower storage costs. The question of how much in the way of storage and management costs can be saved by meeting the OSD inventory goals has not been adequately addressed. The military can realize significant savings only if warehouses can be closed. Warehouses can be closed only if inventory already on hand is disposed of.

Another problem with the inventory reduction goals is the apparent confusion between reducing the requirement and reducing the inventory. When the requirement for a consumable

item is reduced, its inventory does decrease through consumption as long as the item remains actively used. When the requirement for a reparable item is reduced, its inventory does not decrease (or it decreases only slowly because of condemnations). To significantly reduce reparable inventory requires a conscious effort to dispose of inventory.

The rule of thumb for estimating military inventory holding costs is 10 to 15% of the value of the inventory per year. Any savings in holding costs must be compared against the expected cost of having to buy back inventory that was purposely thrown away to meet inventory reduction goals. If the expected cost is greater than 10 to 15% of value, then disposal does not make economic sense.

When evaluating the benefits of disposal of inventory already on hand, a history lesson can be enlightening. A 1984 Washington Post article titled "Millions of Dollars Involved, Air Force Scraps Usable Spare Parts" discusses the "horror story" of the Air Force's disposing of millions of dollars worth of spare parts when a significant amount of those could have been used. (2)

Among other findings, an Air Force audit found that "In many cases, officials said, salvage dealers would sell items back to the Air Force, still in their official boxes or wrappings, at many times the salvage price." Lt Gen Leo Marquez, then Deputy Chief of Staff for Logistics and Engineering, explained that the problem resulted from automatic disposal of spare parts for which there had been no demand within the past 12 months. He said, "quick disposals responded in part to congressional pressure not to build up costly inventories." The rush to reduce inventories could cause the Air Force to revisit horror stories from the past.

How Much Inventory Do We Need?

OSD has developed a set of inventory goals based upon the assumption that Air Force inventory should be reduced in proportion to flying hours. There are other ways to estimate the amount of inventory that the Air Force needs. To estimate the minimum inventory needed to support today's Fiscal Year 1997 (FY97) peacetime and wartime readiness operating requirement, we can simulate building the inventory from scratch. We ask the question, if the Air Force did not have to live with choices made under different conditions, how much inventory would the Air Force want on hand today?

In 1995, reparables accounted for 90% of the value of the Air Force secondary-item inventory. Since they account for the vast majority of the inventory value, we will limit our inventory estimate to reparables. We will focus on the reparables used to support peacetime operations and RSPs.

We will assume that the information (demand rates, additive, and special requirements) used to build the requirement is correct (admittedly a generous assumption). We will concentrate on estimating the impact of the Lean Logistics initiative that the Air Force has implemented to help reduce its spares requirement. Figure 3 compares inventory value (at forecasted unit price) against various total flow time days. Today's cost-weighted total flow time (base repair, order and ship, base processing, reparables-in-transit, shop flow, and serviceable turn-in) is 63 days. How those days are distributed matters, because the closer a delay is to the aircraft (for instance, base repair), the more direct is the impact on aircraft availability. (Table 1 shows the specific scenarios used. For all scenarios except the 63-day baseline, every item uses the same flow time.)

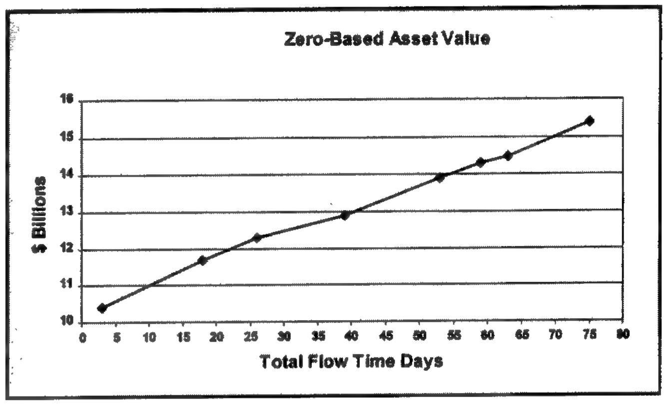

Figure 3. Inventory Impact of Improved Response Times

If built from scratch, today's flow times would generate $14.5 billion in inventory, substantially less than the 1995 reparable inventory value of $27.8 billion. Figure 3 shows how much the Air Force can reduce its inventory value by reducing its total flow time. If the Air Force could reduce its total flow time to three days—which would be virtually impossible—then the inventory value would be $10.4 billion, an inventory "savings" of $4.1 billion. However, such an inventory reduction would come at exceptionally high risk to mission readiness. As the Air Force pushes for faster flow times, the costs and benefits of those flow times must be analyzed.

However, the Air Force cannot start from scratch. Some Air Force spares were bought so the Air Force would be ready to fight

Total Days	Inventory Value ($B)	Base Repair	Order and Ship	Base Processing	Reparables In-Transit	Shop Flow	Service Turn-In
3	10.4	1	1	0	0	1	0
18	11.7	2	7	1	3	5	0
26	12.3	3	11	2	3	5	2
39	12.9	3	11	1	5	19	0
53	13.9	5	11	1	10	26	0
59	14.3	7	11	1	12	28	0
63	14.5						
75	15.4	9	17	4	14	29	2

Table 1. Flow Time Breakout

World War III—not to accommodate one or two major regional conflicts. And yes, the Air Force may even have bought some spare parts by mistake. Nevertheless, whatever the reason, the parts were bought and the money has already been spent. Those parts incur only storage and management costs. When we start with inventory on hand, reducing flow times allows the Air Force to reduce new buys and it generates excess for disposal.

Table 2 shows, given current Air Force assets, the buy savings to be expected if flow times could be reduced, for instance, from 63 days to 53 days and to 26 days. Cutting flow times by ten days would save $500 million in today's buy requirement. Cutting an additional 27 days would save only $22 million more. Moreover, buy savings would be realized on fewer than 2,400 items out of roughly 150,000 reparable support division (RSD) items.

	Buy	
Flow Time	Savings ($Millions)	Number of Items
53 Days	500	2,347
26 Days	522	2,389

Table 2. (Asset-Based) Buy Savings

Why do large reductions in flow times produce so little buy savings? Figure 4 is a histogram of the dates of last procurement for RSD items. The Air Force bought most reparable items in its inventory during the 1980s, when the nation had chosen to build up military capability. It may be true that we would not buy those items now, but what do we gain by disposing of them?

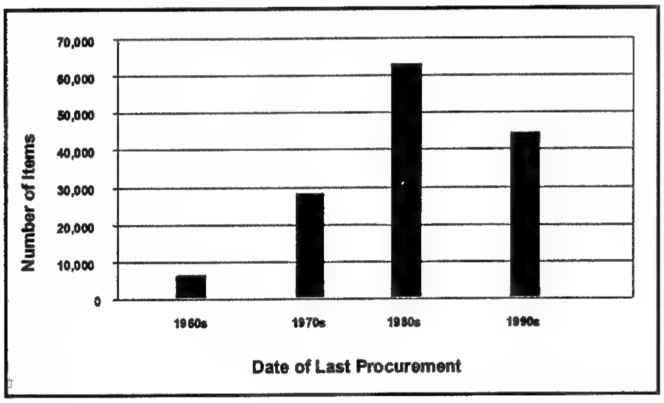

Figure 4. Date of Last Procurement

Excess

While OSD is right to encourage the military Services to dispose of old, obsolete, and unneeded inventory, care must be taken when deciding what inventory is "unneeded." As already discussed, disposing of inventory too early can put the Air Force in the troublesome position of having to buy back, at higher cost, inventory disposed of at salvage cost. Another cost of reducing existing inventory is to force the supply system to respond at a higher-than-necessary speed.

The Lean Logistics program is trying to improve the supply system's responsiveness. Still, it is difficult to make every item move as quickly as possible. It makes more sense economically to allow parts that have adequate inventory to flow through the supply system more slowly by retaining inventory that has already been bought. By allowing some items to have slower response times, the Air Force can concentrate its efforts to reduce flow times on items in a buy position that can generate real savings. Since war plans are never completely stable, the inventory will always contain some items that have enough stock to allow longer flow times. Does it make economic sense to dispose of items and incur the costs of expedited transportation and repair just to lower the inventory value?

Unfortunately, the requirements system cannot easily handle item-specific management. For many flow times, the database structure would not allow for a "fat" and a "lean" time to be recorded. The requirements system is a cumbersome batch system that would have difficulty identifying items in a buy position and managing them differently from the remaining items. When discussing inventory reduction, an area often ignored is that of improving the requirements system. A more flexible and responsive requirements system could lead to leaner inventories.

Summary

Private-sector experience and declining military end strength have motivated OSD to require the military Services to reduce inventory. There are some areas, like fuels, medical supplies, and consumable spare parts, where private-sector experience can guide the military in improving its inventory management. However, when evaluating the benefits of inventory reduction, it is important to remember that the Air Force does not manufacture aircraft. Nor is the Air Force exactly like a commercial airline. The Air Force's mission is to be prepared to fight a war that may erupt with little notice.

Not only do military operations differ from those of the private sector; the way inventory is valued differs. The private sector depreciates old inventory. The military appreciates old inventory by valuing it at the last acquisition cost. Such a valuation method gives an inaccurate picture of inventory changes.

OSD has set inventory reduction goals based upon the assumption that Air Force inventory should decrease proportional to flying hours. That relationship is not valid even in the simple case of the pipeline and safety-level requirement for peacetime operating stock. Many other legitimate requirements, such as wartime requirements, do not decrease proportionately with decreased peacetime flying hours. Furthermore, the low inflation rates incorporated in the inventory goals do not reflect the increased value of the typical reparable spare, because of the increase in complexity of newer weapon systems. All those reasons explain why the Air Force has had difficulty meeting its inventory reduction goal.

In fact, inventory value, or even size, should be a secondary issue. The focus on inventory fails to recognize the investment nature of reparables. Reparable spare parts, which make up 90% of the inventory value, are meant to stay in the inventory over a long period. By their very nature, they have low turnover. The most important thing to focus on is minimizing new buys. One of the reasons the Air Force started the Lean Logistics program was to reduce its requirement for spare parts. By reducing its repair flow times, the Air Force already has reduced the number of spare parts it needs.

Disposal of on-hand inventory should be done with great care. Disposal decisions should be based upon an economic trade-off between relatively small storage and management costs and the

risk of needing to repurchase items. Indeed, in the early 1980s, the Air Force was reprimanded for disposing of items that eventually had to be bought back.

Focusing on whether the Air Force has been buying too many parts or the wrong parts in the past does not necessarily solve current problems. Certainly there are some spares in the inventory that the Air Force may never need and should dispose of. However, it is far better to focus management attention on reducing new assets entering the inventory through process improvements and sharp requirements computations.

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Most Significant Article Award of 1996

The Editorial Advisory Board has selected "Projecting Wartime Demand for Aircraft Spares" by F. Michael Slay, Craig C. Sherbrooke, PhD, and Lieutenant Colonel David K. Peterson, USAF, as the most significant article published in the *Air Force Journal of Logistics* during 1996.

Most Significant Article Award

The Editorial Advisory Board has selected "In Search of Focused Logistics," written by Lieutenant General John J. Cusick, USA, and Lieutenant Colonel Donald C. Pipp, USAF, as the most significant article in the Winter 1997 issue of the *Air Force Journal of Logistics*.

An AGE of Opportunity

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Introduction

The USAF has been increasingly concerned with two major issues since the end of the cold war. First, how to meet the security requirements of a relatively unstable political world; and second, how to reduce the costs associated with acquiring and operating its equipment in the face of increasingly tighter budgets. Alone, either one of these issues could be enough to require substantive changes in USAF operating procedures. Together, and in light of demands to support an unprecedented number of deployments, they have forced the USAF to both examine and make wholesale changes to support concepts and procedures. Today many organizations are looking at the tough requirement of improving both the deployability and affordability of operational units.

In this article, we describe some of the problems associated with aerospace ground equipment (AGE) facing the USAF today and for the foreseeable future. We also describe why now is the opportune time for the USAF and Department of Defense (DoD) to address these problems. We then briefly review the options available and the approach we are taking to examine technologies and concepts to improve both the affordability and deployability of AGE.

The Problems

The problems associated with AGE can be viewed as four separate but interrelated issues which have grown over time. First, there is a problem with both the age of some of the equipment and the designs used to build newer equipment. Second, AGE has not received the periodic improvements typical of aircraft or missile weapon systems. As a result, much of the equipment is relatively unreliable and difficult to maintain. Third, the changing world order and associated changes in DoD missions, philosophies, and requirements have created deployment and affordability problems. Fourth, new weapon systems are on the drawing boards that radically change the utility requirements AGE must meet. These four items have grown from relatively minor issues when most of the equipment currently in use was first designed in the 1950s and 1960s to true problems affecting present and future weapon systems.

Many of the basic AGE designs and some of the actual equipment in use today were created between the late 1950s and 1970. The equipment was designed and built with the Cold War and 1960-era weapon systems in mind. Thus, the equipment was designed to be large, heavy, and with only one function per cart. Size and weight were not a problem at the time because most equipment was prepositioned to support anticipated military requirements. The equipment was purposefully built to be common across multiple weapon systems. However, that added to the size and weight since the equipment needed to respond to the worst case maintenance job on every weapon system. The result is many carts are as large as a small car and can weigh over two tons. (4) These basic designs continued to be used to help reduce the proliferation of machine types, parts, and training. Requesting weapon system designers use existing parts and equipment in more recent designs (for instance, the F-15 and F-16) has allowed the AGE designs to remain useful after the original equipment started to wear out.

In the 1970s and 1980s, the USAF started to realize the reliability, maintainability, and supportability (RM&S) gains available from improved electronics technology and modernized design techniques.[1] The result was a special focus to implement RM&S improvements throughout the USAF. Many weapon systems experienced large RM&S gains from improved electronics and a willingness to spend money early in the program or to modify the systems to reduce parts and maintenance costs throughout the life cycle of the equipment. Unfortunately, these improvements did not reach down very far into the AGE domain. One new piece of AGE designed at this time was supposed to combine an air conditioner and generator on one cart. It had a specification calling for a mature mean time between critical failure of only 46 operating hours and a mature mean time to repair critical problems of 2 hours, with 90% of such repairs not exceeding 8 hours. (7) The USAF fielded this system but it ended up as two carts (one with a generator and the other with an air conditioner) that were larger and heavier than those it replaced. The size, weight, and relatively poor reliability and maintainability made the equipment so problematic the units were eventually abandoned by the users in favor of older equipment.[2]

Over the past five years, the number of operational units has been drastically reduced, especially in overseas locations. At the same time, DESERT SHIELD/DESERT STORM, Bosnia, Somalia, Haiti, and other missions highlight a New World order in which the DoD is expected to play a significant role. (6,12) This role has required, and is expected to continue to require, a large number of deployments to austere locations that typically do not have prepositioned equipment or materials. For virtually all major deployments AGE makes up a major portion of the deployment packages. (2) Current studies have shown that 20-30% of the deployment footprint of a USAF operational squadron

[1] The gains are best evidenced by the F-15 and F-16 aircraft series and studies of the effects of even higher reliability and maintainability on future weapon systems (see references 1, 8, and 15).

[2] The complete history of this equipment is not currently documented. Information was gathered through visits to operational units, procurement agencies, and sustainment organizations.

is created by AGE and its associated spares, personnel, tools, technical orders, fuel, and related items.[3]

In the next 20 years, the DoD may have four new airborne weapon systems in the inventory (the F-22, M/CV-22, Joint Strike Fighter, and Comanche Helicopter). These systems are all being designed to take advantage of new concepts and technologies not available on current weapon systems. They will also require new levels and types of utilities requiring new or modified AGE. For example, most weapon systems of today accept 400 Hertz, 3-phase, 120-volt alternating current electrical power from AGE. However, at least one new weapon system needs 270-volt direct current electrical power. This requires a modification to existing equipment or an additional piece of AGE to rectify the electrical power to an acceptable input. Many of the new weapon systems will also require higher hydraulic pressures than current AGE can provide. In the case of the M/CV-22, the answer has been to design a new cart that provides the higher pressure required. (13) Unfortunately, this cart may end up supporting only the M/CV-22. Supporting such pieces of peculiar AGE is much less cost effective than using common AGE.

The Opportunity

The best opportunity to minimize these problems exists now. The four major weapon systems that will form the bulk of USAF tactical forces and large segments of the other Services are still at least a few years from full production.[4] One well-coordinated effort to organize the multiprogram AGE requirements and define new common AGE could provide major benefits. The equipment could take advantage of new technologies, manufacturing techniques, and design concepts to leapfrog existing equipment. As an added benefit, new equipment may be designed with an open architecture so it can potentially meet the needs of existing weapon systems and allow for upgrades to support future weapon systems not yet on the drawing board.

Several USAF organizations are responsible for overseeing AGE procurement and sustainment. Program offices have the responsibility for defining weapon system AGE requirements and using common equipment to the greatest extent possible. When common AGE is unsatisfactory, the program office must fund for the research, development, and production of peculiar equipment. Air Logistics Centers (ALCs) are responsible for long term support, replenishment, and replacement[5] of both common and weapon system unique AGE. Replacement of AGE by an ALC cannot be easily performed because of restrictions on the development of new equipment. Replacement items must either have the same basic functionality of the replaced unit or be a commercial system with no more than minor alterations. The Subsystem System Program Office (ASC/SM) is responsible for the development of new common support equipment. However, the funding for common AGE development is currently not supported.[6] The Aerospace Ground Support Equipment Working Group (AGSEWG) consists of senior noncommissioned officers and civilians representing all major commands and organizations in the USAF. This group oversees the requirements and program development for common AGE programs. As such, they act as the customers for, and provide command support to ASC/SM and the ALCs, but have no direct control over the weapon system offices. The weapon system program offices often do not place sufficient priority on coordinating their AGE requirements with other program offices. Additionally, each office is reluctant to front the development burdens to design and start the production line for future common AGE.

The result is an opportunity that may slip away. If the opportunity is missed, the result will be a proliferation of peculiar AGE with the resulting peculiar training, spares, and technical orders. DoD can take advantage of this window of opportunity to upgrade equipment and decrease the logistics tail by ushering in a new family of equipment. Ideally, this equipment will provide the same level of reliability and maintainability found in weapon systems. It will be designed to facilitate upgrades as technology and weapon systems change. Finally, the equipment or major equipment components should meet the needs of all Services to expedite joint operations in the future.

The Options

As with almost all hardware items, there are three basic options available to solve AGE problems. The first requires changing or removing the requirements. The second involves infusing new technologies into AGE systems. The third involves repackaging existing AGE utilities. Under most circumstances, these options can be pursued individually or in combination.

Requirements

Changing or removing the requirement for AGE is not usually a feasible option for older weapon systems. However, it can be pursued on new weapon systems. An onboard auxiliary power unit (APU) could be run on the ground to provide all the electricity required for maintenance. This power could be used for more than avionics testing. For example, it could power an air compressor and onboard nitrogen generator to support all pneumatic requirements. It could also power a compressor to provide cooling air and fluids. New technologies are even becoming available to allow local hydraulic actuators to be controlled and powered via the electrical system. About the only thing lacking from this scenario is lighting.

There are penalties with this option which are typically too expensive in the airframe business. Those penalties are weight

[3] Data was synthesized from reference 11, Joint Strike Fighter contractor briefing charts, study of operational organization unit type codes, and discussions with mobility and support equipment personnel in operation units.

[4] Each weapon system has its own manufacturing and deployment schedule but current data shows initial operational capability (IOC) for each weapon system as CV-22 in 2001, F-22 in 2004, Comanche helicopter in 2006, and JSF in 2010. Initial production starts approximately two years before IOC and has a significant ramp time. Full production of the weapon systems is not usually achieved until some time after IOC.

[5] AGE is considered a reparable end item and is not replenished in the vernacular of the USAF supply system. However, this article uses replenishment to define an action to procure items of the same basic design and functionality. Replacement is used to define an action to procure a new design that may or may not have the same basic functionality.

[6] As of March 1996, program element (PE) 0604704F, Common Support Equipment Development, is allotted zero funding starting in Fiscal Year 1997 (FY97). A recent search in applicable databases did not register any common support equipment development PEs.

and space.[7] Aircraft use the main engines to support airborne electrical requirements and ambient air to support the cooling system. An APU capable of supporting the electrical, cooling, pneumatics, and hydraulics requirements as well as a compressor for cooling support would weigh hundreds or thousands of pounds and use precious cubic feet of space. That is why maintenance power is typically provided on the ground. The state of the art in the requisite technologies has not advanced sufficiently to change this basic formula.

Technologies

As can be surmised, if hydraulic, pneumatic, cooling, and electrical generation technologies had been massively improved in the last few decades, the support systems might be in future weapon systems. The reality is that relatively minor to moderate improvements are all that have taken place. For example, axial piston pumps are usually the best technology for providing hydraulic pressures in the 3000 to 6000 pounds per square inch (psi) range typical for aircraft. While there are new design, manufacturing, and materials that can support the creation of the pump, the basic technology has stayed the same for decades. However, there are some new technologies that can be brought to bear in the AGE realm. Each has the potential to improve AGE and help meet current deployability and affordability requirements.

One example of these technologies is improved control systems. Existing AGE have relatively simple and archaic control systems. In some recent research monitoring the draw on generator carts, the electrical output had such large variances that the researchers thought the monitoring equipment was malfunctioning.[8] Advanced control systems could improve the electrical, pneumatic, and hydraulic power to ensure proper levels and tighter variances are provided. Newer control and monitoring systems could also allow future maintainers to view and adjust the temperature, flow rates, and pressure provided by pneumatic and cooling systems more easily and accurately. Additional on-line testing equipment could also ensure that hydraulic fluid is clean, the equipment is functioning properly, and any parts not functioning are identified to ease the AGE maintenance technician's job.

Another example of two technologies that can support modern requirements are fuel cells combined with fuel reformers. This technology set, while relatively immature, boasts the potential to provide electrical power while being much more environmentally friendly. The fuel reformers can take a petroleum-based fuel such as diesel or JP-8 and reform it into hydrogen and carbon dioxide with some sulfur and soot by-products. The hydrogen is then passed on to the fuel cells that combine the hydrogen with oxygen in the air to create electrical power with pure water as a by-product. It has still not been determined if there are size, weight, and cost savings with this technology set. However, the benefits to the environment are so well accepted that the automobile industry is looking towards this technology powering electric vehicles early in the next century.[9]

Equipment Packaging

Some of the largest deployment savings may be in the area of packaging. Packaging refers to how various utilities are configured on mobile frames. Today, most AGE carts have four tires, a frame, fuel system, engine, transmission, and one utility. Creating new designs that improve the system reliability and maintainability of each cart while minimizing the number of frames, fuel systems, engines, and transmissions could provide remarkable savings.[10]

There are various approaches available to change the basic cart structure and common systems. The simplest approach is to combine multiple functions on each cart. For example, the two most used ground utilities on most USAF weapon systems are electrical power and cooling air. Combining these utilities on one cart with the newer cooling fluid utility makes sense due to their high probability of being used at the same time. High-pressure air, low-pressure air, and nitrogen generation are also logical choices for placement on one cart due to the similar nature of their technologies. Adding lights and access to both electrical and pneumatic hand tool power on both of these multifunction carts would be fairly simple. However, it would not remove the need for additional light carts to support general flight line lighting. This leaves only a need for a hydraulics cart. The result is that what constitutes at least seven different carts supporting weapon systems today could be narrowed down to only four carts in the future.

A more interesting approach to combining the functions is a host-parasite system. This system requires defining an open architecture power transmission system and two or three common cart frames. Only one cart has an engine. All the other carts contain one or two utilities and are powered through a linkage with the engine module. Figure 1 on the following page shows one variation of this system that would require a mechanical power linkage. (10) However, the system could also work through an electrical power linkage if the generator was placed on the same cart with the engine. The positive side of the host-parasite system is the ability to only buy, repair, and run one engine, reducing the number of parts and training. In addition, since the fuel system and engine are removed from most carts, they are simpler to repair and more maneuverable by one person. The negative side of this system is the number of carts that must be jockeyed into position to provide multiple functions to an aircraft.

[7] An interesting side note to this issue is these items could easily be made available on large commercial and most cargo aircraft. This is true because these aircraft do not have the size and weight restrictions of fighter aircraft.

[8] These tests were held as part of an Armstrong Laboratory Logistics Research Division effort to define the actual power requirements of aircraft during maintenance. The tests consisted of using any available power cart attached to an aircraft undergoing maintenance. The power frequency, voltage, amperes, and related data were gathered with the use of a distribution box and a Dranetz 4300 meter that allows real time data storage for subsequent analysis. The analyses showed unusually large voltage fluctuations under constant loads and other problems that are considered problematic in most circumstances. Air Force aircraft have on-board power conditioning systems to handle these issues, but they add weight to the aircraft.

[9] For example, Chrysler Corporation announced on 25 Feb 97 (see reference 5) that it will "build within two years a 'proof of concept' fuel cell vehicle." They further stated "consumers might drive fuel cell-powered cars as early as 2010." The rationale stated included that the technology "could improve fuel efficiency by 50 percent, provide up to 400 miles range, be at least 90 percent cleaner, be quieter, require less maintenance and cost no more than today's mid-sized cars."

[10] Studies such as reference 11 show potential savings reaching over a 75% reduction in AGE volume. Tempering this data with affordability concerns highlights realistic reductions in the 25 to 50% range.

There are numerous other options in the solution space. For example, limiting the frames to one or two types that contain a completely open architecture. Each frame can accept most, if not all, utilities through a "plug-and-play" option. Thus, any combination of utilities can be placed on one cart in a relatively short period. Each packaging and technology option has both costs and benefits. The challenge is to marry the multiple selection of technologies to packaging concepts and define the resulting costs and benefits. To implement any solution, the benefits must be defined in deployment and life cycle cost savings. Ideally, the best solution should also be adaptable to multiple Service requirements. The solution should include the ability to meet height requirements for Navy carrier decks, off-road requirements for the Army, and the relatively unrestricted flight line of the USAF.

The Modular Aircraft Support System (MASS)

The Armstrong Laboratory Logistics Research Division (AL/HRG) is currently investing research and development funds in an effort to define a new family of common AGE. In the last two years, we have talked to ASC/SM, the ALCs, weapon system program offices, the AGSEWG, Army and Navy counterparts, USAF field units, and multiple contractors about the current equipment and potential future equipment. Our discussions have highlighted that multiple organizations have concerns in this area and are very interested in developing, testing, and potentially procuring new AGE. As a result, AL/HRG recently awarded a contract to research, develop, and demonstrate a proof-of-concept AGE system under the MASS program.[11]

[11] One initial concern raised in these discussions was the lack of acceptable commercial off-the-shelf (COTS) systems. COTS systems are typically inadequate for numerous reasons, including a lack of ruggedness required for repeated airlift; lack of ability to withstand and be cleaned properly for operation in a biological, chemical, or nuclear conflict area; and they are not packaged to meet the needs of other specific military size and weight requirements.

The vision for the MASS program is to define a new family of AGE that provides an appropriate mix of deployability and affordability while ensuring operational requirements are met. Thus, the effort focuses on researching and developing technologies and concepts that affordably meet all the design constraints and maximize the goals of future weapon systems as defined by the operational commands.

Each opportunity presented by an emerging technology must be carefully analyzed prior to use in a MASS. All have positive and negative aspects in AGE applications and each is at a different level of maturity for the size and operational restrictions a MASS cart must meet. To help the MASS Integrated Product Team (IPT) intelligently review all the options, a wide variety of metrics are being defined. For example, the MASS program is taking a technology maturity approach similar to that used by the Joint Strike Fighter program office (Figure 2). (14) Each technology will be given three technology maturity metrics. The first will define the current state of the technology. The second will define the anticipated maturity by MASS demonstration (approximately the year 2000). The third will define the anticipated maturity for a near-term MASS implementation (approximately the year 2005). These metrics will help define both the technologies that may be used for demonstration purposes as well as those that should be taken into account during a full procurement.

Integrated Product Team (IPT)

User requirements for a MASS are not static. While written requirements provide necessary support to defend a program in austere budgets, they are a poor substitute for regular user interaction.[12] The operational and support commands have

[12] The MASS program and intended system are both built around meeting dynamic requirements. The very concept of a modular system is to allow for the affordable addition, subtraction, or alteration of subsystems as requirements change. This is best described as building in an open architecture to allow for a "plug-and-play" approach to MASS components and subsystems.

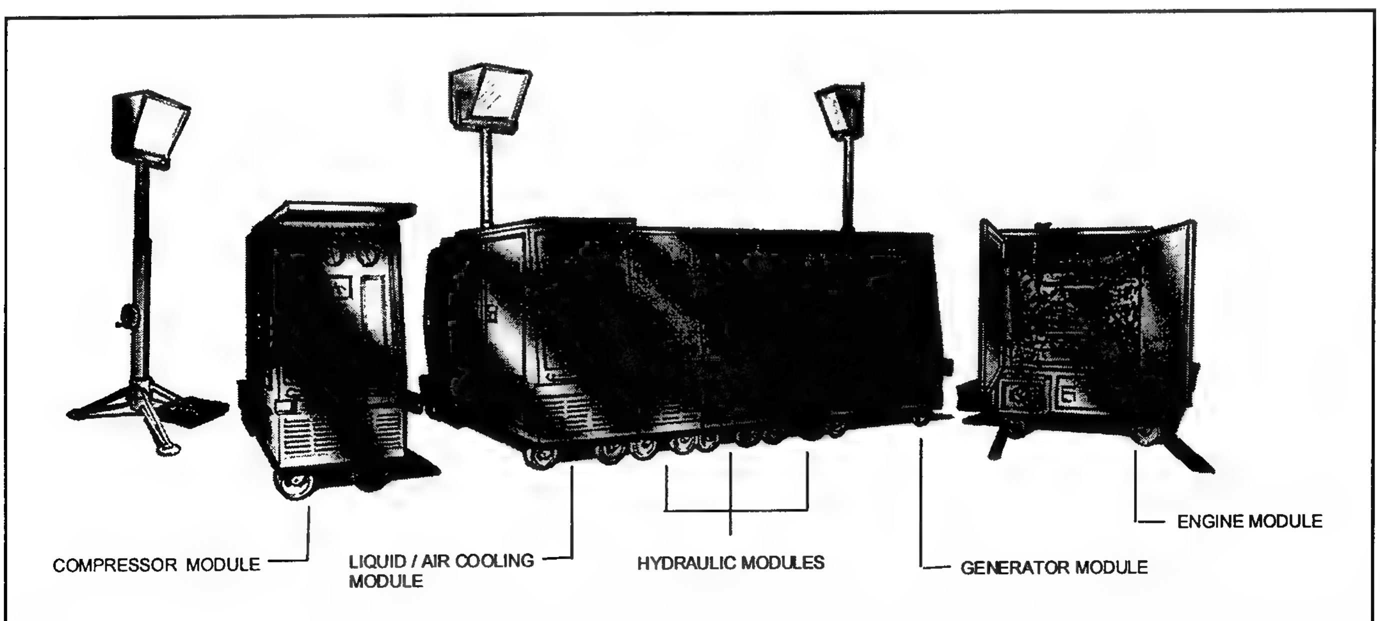

Figure 1. Potential Modular Aircraft Support System (MASS) Host-Parasite System

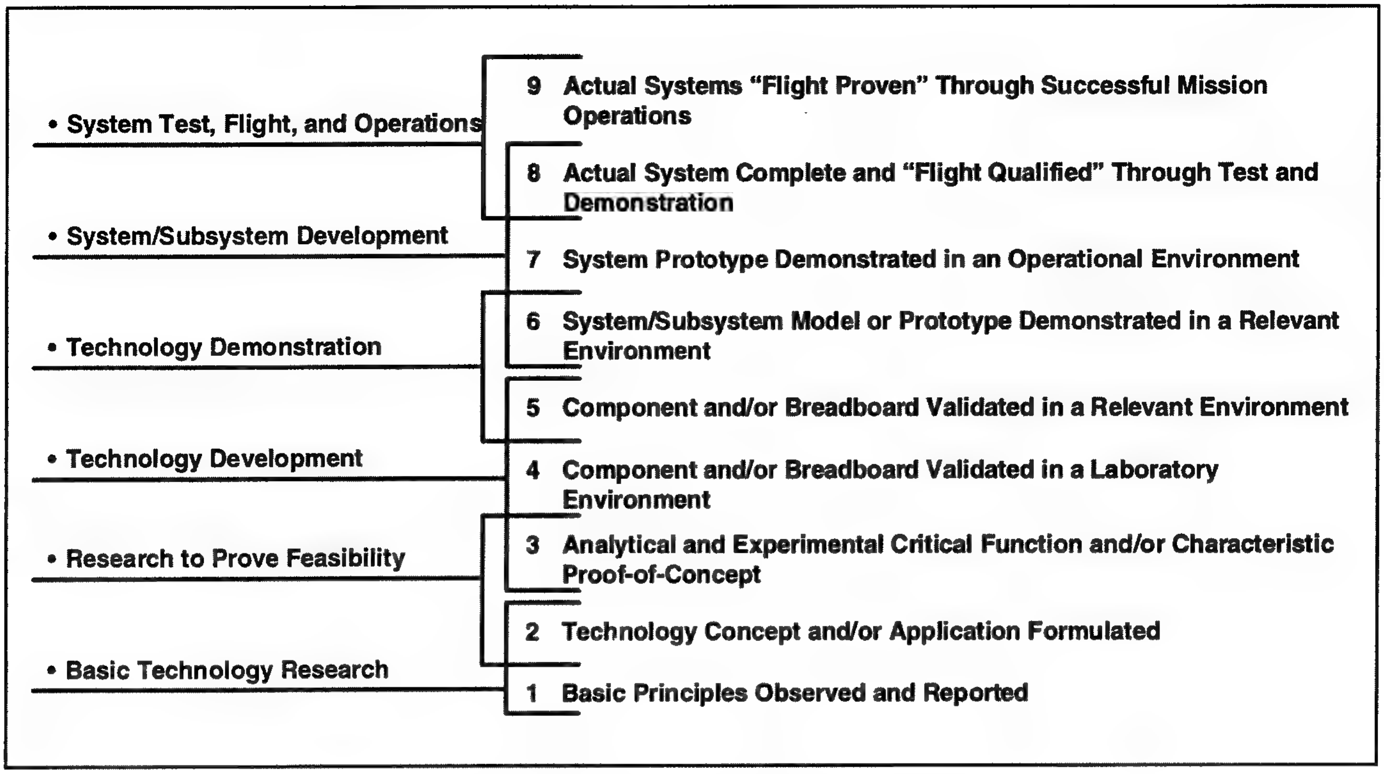

Figure 2. Joint Strike Fighter Technology Maturity Metrics

worked with AL/HRG to define the MASS program over the past two years. Support and direction continues to be received through the MASS IPT. As shown in Figure 3 on the following page, the MASS IPT consists of representatives from the major operational commands, supporting commands, acquisition organizations, and the other Services. This direct customer interaction from personnel experienced and concerned with all aspects of the system life cycle has created a well-balanced program. Their continuous input focuses the program towards their major concerns—affordability and deployability—while ensuring that all other requirements are defined and examined.

The use of the IPT has also helped support attempts to define how to use integrated product/process development (IPPD) in advanced research. The MASS program has been selected by the Office of the Director, Defense Research and Engineering (DDR&E) as one of a handful of pilot programs to implement and analyze how to use IPPD methodologies and tools in advanced research. IPPD methodologies and tools typically include IPTs, Quality Function Deployment, and Six Sigma.[13] These are used during engineering and manufacturing to help create a well-rounded and mature system with minimal down stream design changes. The DDR&E, with support from key Service champions, is using a series of pilot programs to help define and prove the worth of such methodologies and tools, when properly modified, for advanced research. The use of IPPD in conjunction with the IPT has given the MASS program a rare opportunity at excelling on multiple levels and cemented the support of key personnel at a very early phase in the program.

[13] Six Sigma is a statistical modeling approach to define the quality of manufactured goods. Use of the Six Sigma in various research and development programs to support the development of quality products is under review by DDR&E.

The Payoff

The benefits associated with the MASS concept of open architecture systems could range from minimal to remarkable. The result may very well depend heavily on how willing the affected organizations accept both process and product changes. The potential benefits are described in the following paragraphs as they relate to the three main concerns—affordability, deployability, and operations—of the users.

The potential affordability savings cover the entire life cycle. Development costs could be reduced through a single development program meeting the needs of multiple weapon systems. This would be a significant improvement over multiple weapon system program offices each developing peculiar AGE. Acquisition costs are lowered through economy of scale combined with the ability to mix and match components and frames without the need for a system integrator. Operations costs are reduced through smaller fuel storage and use requirements and improved ease of operation. Less fuel will stem from using more efficient technologies and having one engine operating multiple components. Additionally, operational costs could be lowered by having systems designed to be user friendly and far less training intense. Maintenance costs are reduced through a combination of higher reliability, fewer carts and components, and designing for maintainability. Improving the reliability will reduce the number of spares that must be purchased and decrease the number of frames and components that are on the flight line and must be maintained. (1) Improving the maintainability will further reduce both training costs and the time required to perform scheduled and unscheduled maintenance. (3) Finally, disposal costs are reduced since the open architecture will allow for the easy disposal of a single component or frame. No longer will a

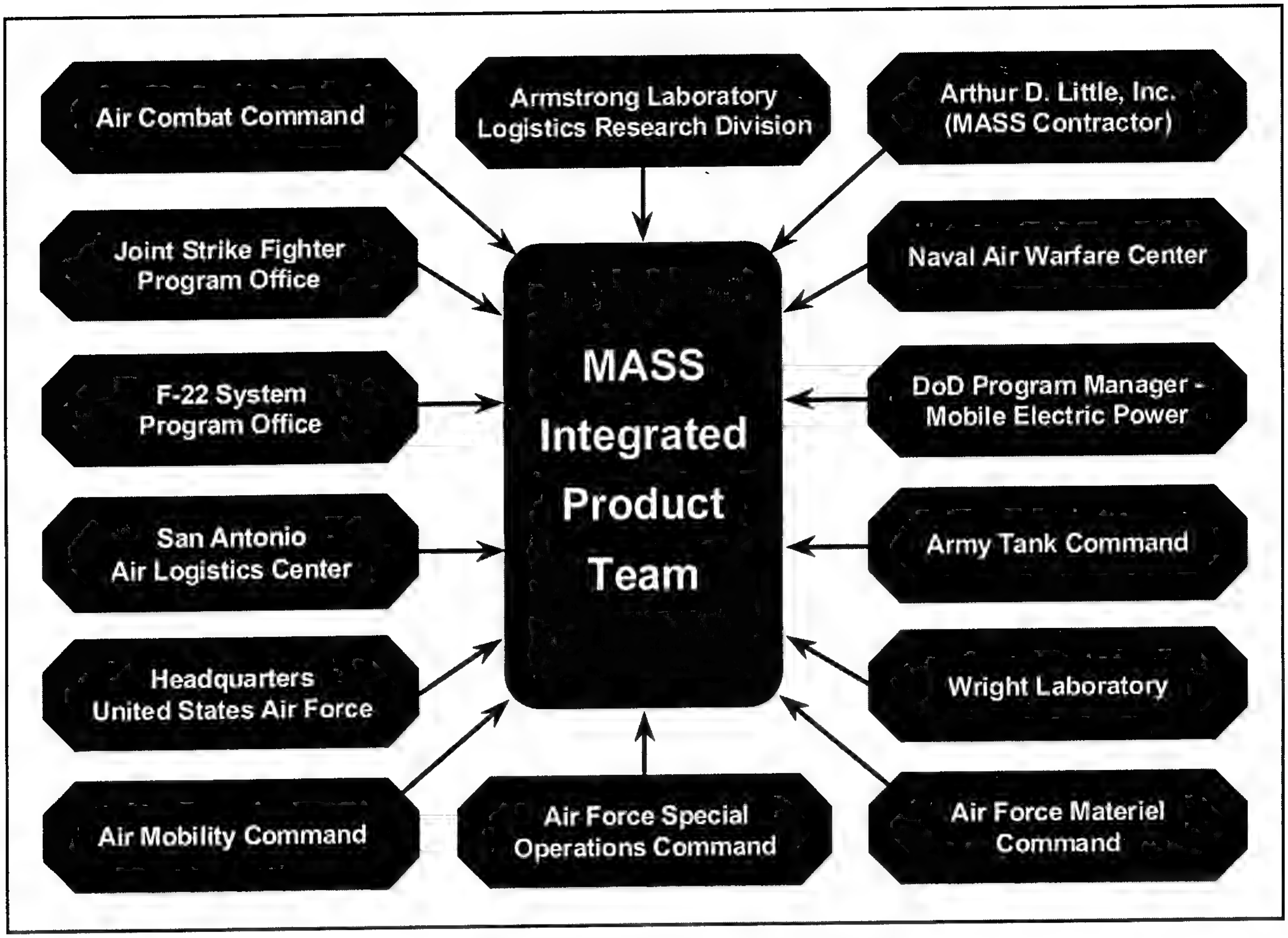

Figure 3. Modular Aircraft Support System Integrated Product Team

whole system require disposal or heavy modification because one part of the system has outlived its usefulness.

Deployability savings also grow as more factors are considered. The open architecture with multifunction carts should immediately pay off in fewer carts being transported. The improved reliability will allow for greater availability of the carts further decreasing the number of carts required. The higher reliability also means that fewer spares will need to be transported. (11) The increased cart availability and improved maintainability results in fewer maintenance actions, thereby reducing the number of technicians, tools, and copies of technical orders. The reduced number of technicians means less food, tents, and other personnel required to deploy. The fewer number of high efficiency engines results in less fuel being deployed as well as less oil, oil filters, fuel filters, and other scheduled engine parts being required. The list goes on and is too large to fully discuss here, but the result is that AGE could be reduced by 50% resulting in deployment savings of 10-15% per F-16 squadron or approximately two C-141 sorties.

The operational benefits associated with the deployment savings are discussed in detail in other papers and reports. (9,11) While numbers vary depending on the scenario, reducing the deployment footprint of operational squadrons allows one of two options. First, the "extra" airlift can be allocated to other airlift operations hastening the full deployment required for an operation. Second, additional aircraft can be deployed and become operational with the same number of airlift sorties over the same time. The addition of operational aircraft in any scenario results in more targets being neutralized per day and hostilities being concluded in a more rapid fashion. Either option provides operational benefits that are desired by all commanders.

Conclusion

This article has shown how AGE problems have grown over the last 40 years. These problems will continue to hamper the DoD until weapon systems no longer need AGE. Since technology has not yet reached this point, the MASS program will take advantage of the current opportunity to define new technologies and concepts that can reduce the problems and increase the operational effectiveness of the USAF and DoD. This opportunity provides an easy and relatively high leverage moment in our evolution from Cold War to New World order.

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(Continued on bottom of page 27)

Current Research

Rome Laboratory

A major research and development (R&D) effort currently underway at the Rome Laboratory (RL) looks at ensuring Department of Defense and Air Force electronic systems are capable of performing their specified functions in diverse military environments. Conducted by RL's Electronics Reliability and Electronics Systems Engineering Divisions, this effort is based on a broad spectrum of research which encompasses all aspects of a system's life cycle. The research stresses development and use of such tools and techniques as modeling and simulation, materials and process characterization, operational assessments, failure modes and effects assessment, and correction. RL's effort uses the same technological thrust as seen in commercial industry to design, develop, produce, and maintain cost-effective, reliable systems.

Translators for Digital Design Netlists

As part of RL's focused reliability sciences research and development effort, the Diagnostics Research Branch developed a set of software tools which converts netlists for digital designs from one netlist language to another. Presently the Air Force has a large investment in digital design data (a good example is test program sets (TPSs) for electronic equipment); however, most of this design data is not usable because the tools that supported the data formats at the time of development and production are no longer commercially available.

The RL developed software provides a viable solution for resolving some diminishing manufacturing source (DMS) and aging aircraft problems. Additionally, RL is assisting Wright Laboratory with their Very High Speed Integrated Circuit (VHSIC) Hardware Descriptive Language (VHDL) Design Environment for Legacy Electronics (VDELE) program. VDELE addresses the DMS problem by identifying and creating computer-aided engineering technologies that support the efficient reengineering of obsolete components, boards, and subsystems. As part of this effort, RL supported the VDELE contractor, Lockheed Martin Tactical Aircraft Systems, by writing a translator that converts an F-16 card design from LASAR V6 into VHDL.

A summary of available netlist translation tools can be found on the World Wide Web (WWW) at the Uniform Resource Locator (URL) http://hp01.arc.iquest.com/usaf_rome/rome-034.html.

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Modular Avionics Test Equipment (MATE) 390 Demonstration

RL recently awarded a contract to Instrumentation Engineering (IE) Inc., to evaluate the effects of upgrading the test equipment hardware and software currently operating on three IE System 390s Automated Test Systems (ATSs) at the San Antonio Air Logistics Center (SA-ALC), Kelly AFB, Texas. Under the contract IE, using commercially available hardware and software, will upgrade the machines, execute the existing TPSs, and determine if major modifications are required. Any modifications that are required will be documented. RL is providing the SA-ALC both technical and contractual support for the effort.

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Analog/Digital Automatic Test System (ADATS) Development Program

The purpose of ADATS is to: (1) Bridge the gap between functional and in-circuit testing and; (2) demonstrate low cost test program set (TPS) development strategies. Under the ADATS program, RL is providing both technical and contractual support to the San Antonio Air Logistics Center (SA-ALC) for the development of advanced board-level tests and diagnostic strategies.

As part of the ADATS effort, Giordano Automation Corporation was awarded a contract to apply model-based reasoning tools and technology to multiple F-15 TPSs at the SA-ALC. The effort will evaluate the ability of Giordano Automation's Diagnostic Profiler to create a "diagnostic knowledge base" for fault isolation in lieu of hard-coded diagnostic test programs. Through the application of their Concurrent Engineering Tool Set and run-time Diagnostician, Giordano Automation's model-based diagnostic reasoning technology will be integrated into the test programs. The execution of the test programs will determine the effectiveness of the Diagnostician in bridging the gap between functional and in-circuit test strategies.

Digitest Corporation, a Giordano Automation subcontractor, is responsible for developing the in-circuit and functional test programs on government furnished HP 3075 test systems. Fault isolation capability associated with the functional testing will be developed using Diagnostician from Giordano Automation. When the unit under test (UUT) functional test reflects unacceptable output characteristics (faults), the results will be passed to the Diagnostician for fault isolation and execution of additional diagnostic tests.

This effort is also evaluating vectorless testing for depot maintenance. This type of in-circuit testing is becoming increasingly popular in production testing. Giordano Automation has subcontracted to GTE the requirement to develop fixtures and test programs for a Scorpion in-circuit test system. The Scorpion test system determines if there is continuity of electrical signals throughout the circuit card by applying low voltage to each nodal input for assessment. This isolates integrated circuits with failed inputs and problems associated with breaks in signal traces and solder joints. Vectorless testing has two potential applications for depot maintenance. First, as a diagnostic aid it provides a quick and inexpensive means of identifying certain sets of faults prior to conducting extensive diagnostic testing. Second, it can

be applied to testing circuit card assemblies where information is unavailable to develop complete fault diagnostic test program sets.

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Imaging Infrared Diagnostics

The purpose of this program is to provide a fast, low cost method for evaluating the operating performance of large phased array antenna systems through infrared (IR) measurement techniques. The IR measurement technique is based on the Joule heating that occurs when electromagnetic energy is absorbed by a lossy material. As electromagnetic (EM) energy passes through the material some of the energy is absorbed and converted into conducted and convected heat energy and into reradiated EM energy. The reradiated EM energy is concentrated in the IR band and can be detected with an IR camera. RL developed a minimally perturbing IR measurement technique to map the EM field intensity over a two-dimensional region. Currently, RL is assessing the feasibility of extending this capability to include magnitude and phase information to evaluate large phased-array antennas. This capability will include the IR measurement techniques to determine the radiation intensity, field of radiation, and antenna alignment. Infrared imaging technology provides a method for measuring the radiation pattern over a large plane rather than at individual points.

An IR imaging system will reduce the dependence on non-government facilities to test and repair phased array antennas. IR measurements will provide a quick diagnostic capability for radar assessments and the capability to determine the operational status prior to or after repairs. It will allow the evaluation of radar in the field, thus eliminating the need to remove the radar from operational status and shipping it to the contractor. It will also provide a baseline for the scope of repair if a contractor facility is required. Ultimately, an IR measurement capability will reduce overall maintenance costs and improve system availability.

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Commercial Equipment Environmental Readiness Factors

One of the primary effects of acquisition reform, particularly with its parallel focus on the use of commercial off-the-shelf (COTS) equipment, has been to inject a great deal of uncertainty in the procurement process for both the DoD and its contractors. Of particular concern is the quantification of reliability performance and risk assessment for COTS equipment targeted for use in environments more severe than those for which the candidate item was originally designed. The mismatch between the design and end-use environment, and the reliability performance that results, is compounded by several COTS-unique issues.

RL recognizes both the DoD and industry will benefit from a stand-alone, easy-to-use, PC-based software tool that addresses the major concerns associated with the selection and use of reliable COTS equipment in military applications. In June 1995, RL awarded the Commercial Equipment Environmental Readiness Factors contract to IIT Research Institute (IITRI) to develop the necessary software tool – SELECT (Selection of Equipment to LEverage Commercial Technology). Planned for completion in mid-1997, the tool allows the user to quantify the reliability (and associated risks) of COTS equipment in severe environments. It also provides visibility into both internal and external design "fixes" that may help eliminate or minimize those risks. The scope of the contract will address the potential use of COTS in aircraft (fixed- and rotary-wing), ground fixed, ground mobile, and space applications. Its breadth will cover those types of COTS equipment considered to be the most likely candidates for use by the military, including computers, signal processors, displays, video equipment, printers, data storage devices, input devices, and radio frequency (RF) communications.

The approach being used includes an extensive data collection and algorithm development effort to develop reliability relationships around environmental characterization, COTS field reliability, COTS failure mechanism data, and COTS equipment manufacturer packaging practices and quality processes. Hughes Aircraft is under contract with IITRI to assist with data collection. These data elements will comprise the basic "baseline system" database to support the tool, where each analyzed item of COTS hardware will be linked to its relevant design and performance attributes. IITRI is also supplementing this quantified data with collected information relating to DoD COTS equipment procurement policies, procedures, guidance, and lessons learned. This information will be integrated into the SELECT tool structure to highlight risk mitigation guidance for the user in the form of potential COTS design alternatives. The coupling of quantified COTS reliability performance estimates with the identification and ranking of related risks and potential solutions associated with the selected item(s), will allow the SELECT tool user to make consistently informed decisions regarding COTS equipment procurement and application.

Both the SELECT program and the database upon which it is built are being structured to ensure the amount of information and input required from user is minimized. They will be restricted primarily to identification of the COTS equipment of interest, the intended application environment and, where potential design modifications are identified, the nature of the "fix." Manipulation of the various features of the tool, which is being programmed using Visual Basic 4.0, will be through standard Windows 3.1 point-and-click techniques and graphical user interfaces. The tool will make use of graphics to display the impact and risk of, for example, changes in environment on COTS performance reliability, as well as provide tabular report summaries and database administrative information. The usefulness of the SELECT program is intended to extend beyond its anticipated snapshot in time at the end of the contract. The baseline system database structure that SELECT is based upon will support continued growth of the tool to incorporate the latest COTS technologies and equipment, additional application environments, or future lessons learned, policies, and guidance.

A World Wide Web Home Page for the SELECT tool is being developed. It will provide an extensive and broad-based avenue for promoting the results of the study and the features of the software tool.

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Low Cost Dual Use Environmental Measurement Device (EMD)

There is a need in the military logistics community and the commercial transportation industry for a low cost EMD to

measure and record environmental stresses during transportation. EMDs have the potential to reduce the billion dollars per year in damages suffered by the transportation industry by determining when and where damage occurs to materiel being shipped or warehoused.

RL has contracted with Event Tracking Service, under the Small Business Innovative Research Phase II effort, to design, build, and deliver 75 EMDs.

These EMDs to be supplied by Event Tracking Service will be capable of measuring, recording, and time stamping shock and temperature for a 60-day period (powered by self-contained batteries) and will be approximately one-half inch thick and roughly the size of a credit card.

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Automated Requirements Translation (ART) Tool

Before last year's release of the Automated Requirements Translation (ART) Tool software there was not an automated way to translate system operational needs into system reliability, maintainability, and diagnostics (RM&D) specifications. Numerous DoD and government contractor organizations have started using this tool and ART is now becoming the new standard these organizations base their system requirements translation process on. Developed for RL by a team of ITT Research Institute and Northrop-Grumman personnel, ART is capable of translating the user-defined operational requirements (sortie rate and mission capable rate) into system design specifications RM&D. Most notably, contractors on the Joint Strike Fighter (JSF) program used ART during, and subsequent to, the submittal of their concept development phase proposals for the JSF program. Not only does the software translate from user requirements to system RM&D specifications, but it will also perform the reverse process, translation of system RM&D (specifications, predictions, etc.) into anticipated field operational performance. ART can perform these translations for Air Force and Navy aircraft (fighters, bombers, cargo, attack, and tankers) and their electronic subsystems for both system upgrade programs and new system acquisitions. The potential exists to expand the ART tool to translate requirements for platforms other than fixed-wing aircraft.

The ART software runs on a standard PC (Windows version 3.1 or higher). It is available free of charge for use on government programs. The software, user's manual, and technical references are typically provided by e-mail. Requests for the software should be directed to Frank Born at the telephone number or e-mail listed below.

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Outsourcing—Determining the "Hurdle Cost"

M. Alex Milford
Houston S. Sorenson

Introduction

The Department of Defense (DoD) budget and force structure have decreased by one third since 1990. However, the operations and maintenance (O&M) portion of the budget has decreased by only 17% and now constitutes a greater portion of the DoD budget (36% versus 30%). Conversely, the procurement accounts, from which force modernization is funded, have decreased from 27% to 16% of the overall DoD budget. (3) The reduced threat, entitlements growth, and public opinion are expected to force even greater reductions in future DoD budgets. This situation will create additional pressure on DoD leaders to find ways to support operations more effectively and efficiently.

Recognizing the need to reduce O&M costs to free resources for weapons systems modernization, DoD leaders are evaluating a range of options to reduce costs and improve support. *Outsourcing*, the transfer of support functions previously performed in-house to an outside provider, holds the promise of providing some of the savings needed. Outsourcing has historically saved DoD 30% when applied to functions previously performed in-house. (1) DoD now aggressively pursues outsourcing of support functions, such as logistics, to achieve the needed savings for force modernization.

Outsourcing can be beneficial if the cost of obtaining the service from an outside source is less than the cost of providing the service organically and the risk of degraded performance is low or can be mitigated. However, a major difficulty in determining the feasibility of outsourcing and privatization is the time-consuming, difficult, risky, and expensive effort required obtaining contractor cost data outside the formal solicitation process. This is especially the case relative to estimating the costs that will be incurred by an outside organization taking over a previously organic function. Estimating the costs for the new organization requires detailed insights (which are not easy to come by) or informed judgments (which are subject to disagreement) into how a new entity would organize to perform the outsourced functions, what new or improved business processes they might employ, what their cost structure will be, and what business decisions they would make in developing a cost proposal, among others. These considerations are all important determinants of the functional costs that an outside source would propose and they tend to make advance estimates of cost difficult and risky. This article describes a methodology, referred to as a hurdle cost analysis, to provide an initial indication of the financial feasibility of outsourcing "non-core" activities. Non-core does not infer non-essential; it simply refers to activities that others can do better, faster, less expensively, or more reliably.

The Hurdle Cost Analysis Methodology

The hurdle cost analysis relies on two estimates of cost to develop preliminary indications of the financial feasibility of outsourcing. These estimates are discussed in the following paragraphs.

The end objective of the hurdle cost analysis is a comparison of the hurdle costs (discussed below) to a cost base from which savings must be achieved. In Step 1, the cost base from which savings must be taken is estimated. This base may be referred to as the cost savings opportunity base. What we seek to do with the hurdle cost analysis is to look at the costs that must be overcome (the hurdle) in relation to the size of the base from which these savings must be wrung. The relative size of the hurdle is a good indication of the financial feasibility of outsourcing. If, for example, an existing mission must be performed by an alternate source at 50% of its current mission costs, it may be possible for an knowledgeable decision maker to infer that outsourcing will be difficult to justify from a purely financial perspective. If, on the other hand, the required cost savings represent a small proportion of the cost savings opportunity base, outsourcing is more likely to be economically feasible and thus may be deserving of closer scrutiny. To illustrate the hurdle cost analysis methodology, this article uses hypothetical data from a postulated DoD logistics support organization.

Step 1: Determine Current Cost (Baseline) to Perform the Organization's Mission

In this step, estimates of mission costs under the existing organizational structure are developed; that is, the subject activities are performed at the same location by the existing organic unit. In this context, the term "organic" denotes an organizational unit entirely staffed with military personnel and/or civil servants and managed as an integral part of a larger governmental entity. Table 1 presents an example of how the baseline, or "as is," costs might be developed. One of the advantages of the hurdle cost analysis is found in the fact that it is typically easier to characterize activity costs as they currently exist than it is to estimate "to be" costs. In this hypothetical example, one could consult a Table of Organization, interview experts currently performing the subject mission, and review historical costs to estimate baseline mission costs.

Part of this step relating to the determination of baseline costs includes the identification of activities that are not candidates for outsourcing due to their "inherently governmental" nature. In addition, some insight into the existing cost structure is gained that can also help characterize the cost savings opportunity base.

For example, if the cost of purchased parts is an important element of baseline mission cost, it is not likely that these costs represent a great opportunity for savings. Once the baseline mission costs are estimated, adjustments to them may be appropriate to properly characterize what we refer to as the cost savings opportunity base.

Time Equivalents	Grade/Step	Salary	(132 %)	Equivalent Costs	Subtotals
Equipment Specialists (ES)					
1.00	GS-11/8	43,143	57,143	57,143	
1.00	GS-11/10	45,475	60,232	60,232	
ES Supervisor					
0.20	GS-13/5	56,504	74,840	14,968	132,342
Engineers					
1.00	GS-12/6	48,916	64,789	64,789	
1.00	GS-12/5	47,518	62,938	62,938	
1.00	GS-12/7	50,314	66,641	66,641	
Engineer Supervisor					
0.33	GS-13	56,504	74,840	24,697	219,065
Item Managers (IM)					
1.00	GS-5/8	23,533	31,169	31,169	
1.00	GS-11/2	36,147	47,877	47,877	
1.00	GS-11/3	37,313	49,421	49,421	
1.00	GS-11/6	40,811	54,054	54,054	
2.00	GS-9/2	29,876	39,571	79,142	
1.00	GS-9/5	32,768	43,401	43,401	
1.00	GS-9/6	33,732	44,678	44,678	
1.00	GS-9/8	35,660	47,232	47,232	
1.00	GS-12/6	48,916	64,789	64,789	
IM Supervisor					
0.33	GS-13/5	56,504	74,840	24,697	486,460
Production Manager					
1.00	GS-11/7	41,977	55,599	55,599	
Logistics Manager					
1.00	GS-12/5	47,518	62,938	62,938	
Logistics Supervisor	GS-13/5				
0.14		56,504	74,840	10,478	129,014
Resource Manager					
1.00	GS-11/3	37,313	49,421	49,421	49,421
Contracting Officer					
2.00	GS-11/3	37,313	49,421	98,842	98,842
Technical Data Writer					
1.00	GS-9/9	36,624	48,508	48,508	48,508
	Totals			1,163,653	1,163,653
OMB Circular A-76 Factors					
Line 1 Personnel					1,163,653
Line 2 Materiel and Supply				(Supplies)	30,000
Line 3 Other Specifically Attributable				(Travel and Other Direct Costs)	53,146
Line 4 Overhead (12%)					139,638
Line 5 Additional					
Line 6 Total In-House Cost					1,386,437

Table 1. Baseline Costs

Step 2: Determine the Organization Outsourcing "Hurdle Cost"

The second fundamental cost estimate in this analysis relates to an estimate of the costs that must be overcome: that is, saved, under an outsourcing scenario to make such an initiative attractive to the government. These costs include both non-recurring elements (such as the cost to place an outsourcing agreement) and recurring elements (such as the costs to provide management oversight of the contractor). The total of these recurring and non-recurring costs represent a "cost hurdle" which must be cleared in order for outsourcing to make sense financially.

This "cost hurdle" approach is analytically sound and does not require guesses about how private industry would organize to perform an organization's mission and what that postulated response would cost: that is, what cost a contractor would propose. While this approach is somewhat non-traditional, it avoids the requirement to make a comprehensive set of assumptions about how industry would respond from a functional perspective and all the peculiar business decisions that would be reflected in a particular contractor's cost proposal. This approach eliminates a significant amount of work, the end result of which is potentially controversial and uncertain because of the large number of ground rules and assumptions that must be adopted. By focusing instead on the cost hurdle that must be overcome, this approach allows management to readily assess the financial feasibility of outsourcing, with and without considering performance risk.

Characterizing Baseline Costs—An Example

The baseline costs for the organic service provider in this example are developed using the grades and steps of the personnel currently performing the organization's functions, annual salary information from standard government cost tables, Office of Management and Budget (OMB) Circular A-76 factors for fringe pay and overhead, and budgets for travel and supplies/equipment. (2) Costs for facilities maintenance and repair, rent, utilities, and capital improvements (to the extent they are not already addressed in the 12% overhead factor) were not included since a key assumption in this hypothetical example is the new performing organization (assumed to be a commercial entity in the following discussion) would be furnished space in government facilities. Such an arrangement would be advantageous, at least initially, due to the need for the winning contractor to interface with other offices in the larger organization on a continuous basis. Table 1 reflects the estimate of baseline costs incurred organically. In this hypothetical case, the total annual cost is estimated at about $1.4 million.

Estimating the Outsourcing Cost Hurdle and the Cost Savings Opportunity Base

The fundamental goal of the hurdle cost analysis is to calculate the cost savings an outside provider must generate relative to the government's organic cost of performing the mission considered for outsourcing. Hurdle cost analysis provides a method to determine if outsourcing a function makes financial sense. To achieve this goal, it is necessary to (1) determine the scope of the organization's efforts subject to outsourcing, and (2), estimate the incremental costs the organization will incur directly related to outsourcing. This latter objective represents the hurdle cost of outsourcing. The following discussion addresses each of these two objectives noted above. However, before proceeding into those topics, it is appropriate to address briefly the use of present value in this analysis.

The concept of present value recognizes the time value of money in that it discriminates between the value of a dollar now and the value of a dollar at some point in the future. Present value analysis employs a discount factor to restate, or "discount," future cash flows into terms of a single reference year and takes into account opportunity costs. In a hurdle cost analysis, this technique recognizes the timing differences with respect to when hurdle costs are incurred and when postulated cost savings are generated. Using the concept of present value, the size of the cost hurdle relative to the savings base can vary under different assumptions with respect to timing. For example, the non-recurring costs associated with outsourcing are incurred at the beginning of the time period of interest. While the contractor does not have to "earn" these incremental costs back

immediately, the longer the delay in the recognition of the required cost savings, the larger they must be in nominal terms.

For this analysis, it was assumed that the non-recurring costs are "amortized" equally over a three-year contract period. Additionally, as documented in the tables that follow, this analysis assumed an annual inflation rate of 3.0% and a discount rate of 7.0%, approximately equal to the current Treasury borrowing rate. By definition, it was assumed that the government demands a real rate of return on its investment of 4.0%.

Scope of the Organizational Efforts Subject to Outsourcing

To estimate the baseline cost from which the hurdle savings must be generated, the scope of the organizational functions that can be outsourced must be determined. It is assumed that certain existing personnel perform inherently governmental functions that are not appropriate for outsourcing. In the case of the example organization, the inherently governmental functions require continued staffing by five full-time equivalents (FTEs) as shown in Table 2. In a "real" analysis, the nature of these functions and the staffing required to execute them would be determined in discussions with the organization's managers and subject matter experts. For the purposes of demonstrating the hurdle cost analysis, the nominal cost baseline of approximately $1.386 million for the current service provider is reduced dollar for dollar by the cost of functions that will remain organic ($.297 million). Thus, the estimated cost savings that the outside provider must generate will come from a baseline substantially less than the total cost of $1.386 million. As one example of the conservative nature of this sample hurdle cost analysis, it is assumed the outside provider of the outsourced services will not duplicate any of these costs. To the extent this assumption does not hold true, the financial analysis of outsourcing understates the difficulty of making this initiative financially attractive to the government.

Estimating the Outsourcing Cost Hurdle: Non-Recurring Costs

The cost hurdle any outsourcing initiative must overcome is comprised of non-recurring costs (those costs relating to outsourcing incurred but once) and recurring costs (those costs incurred over and over again). Table 3 shows a couple of examples of non-recurring costs associated with outsourcing. One important component of non-recurring costs relates to placing the contract vehicle initially, including the costs of efforts to prepare the necessary approval documentation to support an outsourcing decision; the costs to prepare a draft and final solicitation package; costs associated with evaluating contractor technical, management, and cost proposals; and costs related to final source selection. In this example the costs associated with

	Grade	Full Time Equivalents	Duration (Years)	Direct Salaries	Salary + Fringes	General and Administrative Overhead	Total
Logistics Manager	GS-12/5	1.00	1.00	47,518	62,938	7,553	70,490
Resource Manager	GS-11/3	1.00	1.00	37,313	49,421	5,931	55,352
Item Manager	GS-11/6	1.00	1.00	40,811	54,054	6,487	60,541
Contracting Officers (2)	GS-11/3	2.00	1.00	74,626	98,842	11,861	110,703
Subtotal					**265,255**	**31,831**	**297,086**

Table 2. Annual Cost of Inherently Governmental Functions

	Grade	Full Time Equivalents (FTE)	Duration (Years)	Direct Salaries	Salary + Fringes	General and Administrative Overhead	Total
Costs of running the competition (approval documentation, requests for information, requests for proposals, selection of vendor, etc.)							
Contracting Officer (1FTE)	GS-12/6	1.00	1.00	48,916	64,789	7,775	72,564
Subject Matter Expert(s)	GS-12/5	1.00	1.00	47,518	62,938	7,553	70,490
Acquisition Manager	GS-12/5	1.00	1.00	47,518	62,938	7,553	70,490
Transition costs:							
·Transition planning and execution							
--1.5 FTE for 3 months	GS-11/3	1.50	0.25	13,992	18,533	2,224	20,757
·Redundancies of workforce (until vendor can fully take over)							
--Full force for 2 months (excluding employees that remain)							181,559
							-
Subtotal, Non-Recurring Costs							**415,860**

Table 3. Non-Recurring Hurdle Costs Incurred "Up Front"

placement of the outsourcing contract vehicle are primarily manpower related and are estimated to be equal to the fully burdened salaries of three FTEs over a one-year period. In addition to the costs of placing the outsourcing contract, there are non-recurring costs associated with the transition to an outside service provider. These transition costs occur both prior to and after contract award and are additional costs directly related to outsourcing.

Estimating the Outsourcing Cost Hurdle: Recurring Costs

In this example, the most obvious recurring costs directly related to outsourcing consist of the costs incurred by the government to provide the necessary management oversight and to discharge the administrative responsibilities and obligations that the government incurs in any contracted effort. Table 4 shows the estimated recurring hurdle costs associated with outsourcing. Note that these recurring costs are stated on an annual basis.

Table 4 demonstrates that the outside provider must save at least $.118 million annually from the cost savings opportunity base in its execution of outsourced functions to reach the point of financial "indifference" on the part of the organization.

In addition to the incremental costs of government oversight, a commercial service provider will present another element that represents a recurring cost from the government's perspective, namely, profit. The comparable organic cost base does not include any provision for profit, so to make the government indifferent from a financial perspective, any profit earned by the outside service provider must be covered by cost reductions. For the sake of this analysis, it is assumed that the outside provider would set an annual profit target equal to 8% of the comparable organic cost base of $1.089 million (the nominal annual organic cost base of $1.386 million reduced by the cost of functions that will remain organic ($.297 million)). Applying this rationale results in an estimated annual profit objective of $.087 million. This profit objective, in addition to the recurring costs of contract oversight and administration, must be extracted from the cost savings opportunity base in order for outsourcing to be financially attractive to the government.

Present Value Analysis

Prior to presenting the results of the present value analysis, the ground rules and assumptions explicitly stated above or assumed implicitly, are summarized. The relevant assumptions and ground rules include the following:

- No job losses, that is, no severance pay.
- No redeployment, that is, no training expenses for displaced employees.
- No relocation, that is, no relocation expenses for displaced employees.
- Functions that remain organic are not duplicated by the outside provider.
- Outside provider utilizes existing infrastructure on a continuing basis.
- Outsourcing contract duration of three years.
- Fringe benefits on salaries total 32.45%.
- General and administrative overhead on salaries and benefits totals 12%.
- Outside provider's profit objective is 8% of existing comparable organic service costs.
- Inflation at 3% per year, Treasury borrowing rate at 7%.

In this hurdle cost analysis, it was estimated that the outside provider must perform the outsourced organization's functions in such a way as to recover non-recurring costs of $.416 million and annual recurring costs of approximately $.205 million (the cost of recurring organic management and administration plus an allowance for outside provider profit). These costs are all stated in terms of Fiscal Year 1997 (FY97) dollars. As shown in the top portion of Table 5 on the following page, the hurdle cost is approximately $.987 million (discounted to the current year). In other words, the outside provider would have to perform the outsourced functions over the period of the contract for approximately $.987 million less than the estimated organic cost of these functions. Looking at various assumed relative cost reductions (5%, 15%, 25%, and 35%), it is not until the outside provider performs these functions for approximately 35% less than the current organic cost to the organization that outsourcing breaks even financially.

	Grade	Full Time Equivalents (FTE)	Duration (Years)	Direct Salaries	Salary + Fringes	General and Administrative Overhead	Total
Costs to manage vendor-new costs							
Contracting Officer Technical Representative (0.5 FTE)	GS-11/3	0.50	1.00	18,657	24,711	2,965	27,676
Quality Assurance Manager	GS-11/3	1.00	1.00	37,313	49,421	5,931	55,352
Subject Matter Expert(s)	GS-12/5	0.50	1.00	23,759	31,469	3,776	35,245
Subtotal, Recurring Management Costs							**118,272**

Table 4. Recurring Hurdle Costs Incurred Annually

On face value, a reduction in comparable service costs of approximately 35% is a hurdle that is unlikely to be overcome, especially considering the fact it is probably optimistic (that is, the financial hurdle is more likely to be greater than 35%, rather than lower). In this hurdle cost example, some of the assumptions adopted that are perhaps unduly favorable towards outsourcing (they are not reflected in the outsourcing hurdle cost) include the following:

1. No job losses, retraining, or relocation expenses. In an outsourcing scenario, there are likely to be dislocations that give rise to non-recurring costs that are not currently reflected in the computed cost hurdle. To the extent such costs are incurred, the hurdle cost will be greater.

2. Functions that remain organic are not duplicated by the contractor. Earlier in this article, five FTEs were identified that would continue to perform the organization's functions that are inappropriate for outsourcing (that is, these functions remain organic). The assumption the outside provider would not have to duplicate any of the functions performed organically is likely to be optimistic. For example, the functions performed by the existing organization's logistics manager would likely be duplicated to some extent by the contractor's program manager.

Present Value Analysis							
				Discounted $	**Inflation Rate**	**Discount Rate**	**Inflated $**
Total Costs-Outflow							
Non-Recurring Costs ***New***		415,860	(Year 0)		3.00%	7.00%	
Annual On-Going ***New Costs***		118,272	(Beginning Year 1)				
Annual Contractor ***Profit***		87,148	(Beginning Year 1)				
		Year 0		415,860			
		Year 1		197,741			211,583
		Year 2		190,349			217,931
		Year 3		183,233			224,469
Hurdle				**987,183**			
Annual Cost Savings Opportunity Base:				**Discounted $**	**Inflation Rate**	**Discount Rate**	**Inflated $**
1,089,351					3.00%	7.00%	
Cash Savings-Inflow							
	At	5%					
		Year 1		52,431			56,102
		Year 2		50,471			57,785
		Year 3		48,585			59,518
Inflow at 5%				**151,487**			
	At	15%					
		Year 1		157,294			168,305
		Year 2		151,414			173,354
		Year 3		145,754			178,554
Inflow at 15%				**454,462**			
	At	25%					
		Year 1		262,157			280,508
		Year 2		252,357			288,923
		Year 3		242,923			297,591
Inflow at 25%				**757,436**			
	At	35%					
		Year 1		367,020			392,711
		Year 2		353,299			404,492
		Year 3		340,092			416,627
Inflow at 35%				**1,060,411**			
Break even = ~35% annual savings over a three year period.							

Table 5. Present Value Analysis

Likewise, the functions performed by the organic service provider's item managers' supervisor would probably be duplicated to some degree by the outside provider's item managers' supervisor. To the extent such duplicative costs are incurred, the hurdle cost will be higher.

3. Part of the comparable cost base of one million dollars represents material and travel costs. From Table 1, about $.083 million of the comparable cost base relates to travel, supplies, and other non-labor costs. It is unlikely the outside provider will be able to wring substantial savings from these non-labor elements of cost. To the extent that this is true, the outside provider will have to achieve the necessary cost savings out of an even smaller cost base, making the necessary relative cost savings even higher than 35%.

Conclusion

The foregoing example describes the hurdle cost analysis concept and demonstrates its application in evaluating a postulated outsourcing initiative. The hurdle cost approach to analyzing the economic feasibility of outsourcing offers some advantages relative to comprehensive cost comparisons that are part of OMB A-76 Studies. Most importantly, it avoids the time-consuming, difficult, risky, and expensive effort required to obtain contractor cost data outside the formal solicitation process and estimate the mission cost an outside service provider would incur. Its advantages in this area are magnified as the activity under consideration diverges from well-understood functions that have clear commercial counterparts. An analysis of hurdle costs can provide a quick indication as to the feasibility of outsourcing a particular activity and potentially avoid the requirement to perform a rigorous A-76 study. However, if the hurdle cost analysis does indicate that outsourcing is potentially attractive to the government, very little of the work executed in support of the hurdle cost analysis is wasted. For example, a more demanding A-76 study would reutilize much of the work done to characterize baseline (or "as is") costs as well as the work which yielded estimates of the incremental, or hurdle, costs. However, each potential outsourcing initiative must be reviewed carefully to make sure the cost savings opportunity base and hurdle elements are well understood. For example, there may be expectations of capital investments by the successful offeror or a different place of performance that could give rise to incremental "footprint" costs. These are important considerations in determining the hurdle cost. In short, while the hurdle cost analysis approach is relatively straightforward, each outsourcing initiative must be suitably defined and understood in order to get the elements of the hurdle right and permit their comparison to an appropriate cost savings baseline.

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Using Aircraft Availability Targets to Determine Spare Parts Requirements

The Air Force uses aircraft availability targets to compute reparable inventory requirements. These targets express the percentage of aircraft not grounded for parts [one minus total not mission capable supply (1-TNMCS)] during peacetime that are required to execute the greater of either a peacetime or wartime requirement. The target will be the greater of either the 1-TNMCS rate required to accomplish the peacetime operational requirement or the 1-TNMCS rate required at the initiation of hostilities needed to accomplish the wartime requirement. Targets are set for individual weapon system types and are based on the entire Air Force inventory. For example, an A-10 target of 87.1% means that at least 87.1% of the entire A-10 fleet can't be grounded for parts if the Air Force is to meet the A-10's highest operational requirement. Said another way, no more than 12.9% of the A-10 fleet can be down for parts (TNMCS). The rest of this article outlines what the targets are used for, how the targets came about, how they are determined, and some perspectives on mission capable (MC) rates and requirements.

Aircraft availability targets are used to determine the amount of safety stock required to cover variability in the peacetime spare parts pipeline. Targets are updated annually to ensure resourcing tracks with operational requirements. In addition, because of the lead-time involved in the spare part procurement process, targets are computed for a date three years in the future. During the Recoverable Consumption Item Requirement System (D041) spare part requirement computation, the Aircraft Availability Model (AAM) computes the safety stock required for each item with a demand history. The AAM uses the target as a means of identifying the number of parts needed to yield the required availability at the least cost. The Readiness Spares Package (RSP) is a stand-alone package, independent of, and additive to the peacetime spare parts requirement and is not computed using the availability target. Additionally, there is also a significant amount of nondemand based spares requirements which are based on something other than availability targets.

The Air Force did not always use availability targets to set spare part safety levels. Prior to 1988 and the implementation of the AAM, the safety stock was determined using the Variable Safety Level (VSL) model. This model was designed to achieve a 92% retail fill rate that was not based on aircraft availability or operational requirements. The VSL is still used to determine non-aircraft related requirements. Even after the advent of the AAM, the aircraft availability targets were not initially based on operational requirements. When the AAM was first implemented, the targets were set so the spares buy for each weapon system was at least equal to the amount bought in the previous year using the VSL. This was accomplished using a cost availability curve similar to the curve in Figure 1. With the cost on the Y-axis and availability on the X-axis, targets were selected by moving up the Y-axis until the cost for each weapon system matched what was spent the previous year. Later targets were modified using the same curve, however the amount to be spent on safety stock was established by determining where the point of diminishing returns was for aircraft availability. It was not until 1992 that targets were set using true operational requirements. The Air Force implemented a parametric model that could translate peacetime and wartime operational requirements into peacetime and wartime weapon system MC rates. The model that computes the MC rate requirements is known today as the Windows Logistics Assessment Model (WINLAM). From these MC rate requirements we derive the aircraft availability targets for each weapon system group. The greater of either the peacetime or the wartime availability target is the target ultimately used in the AAM.

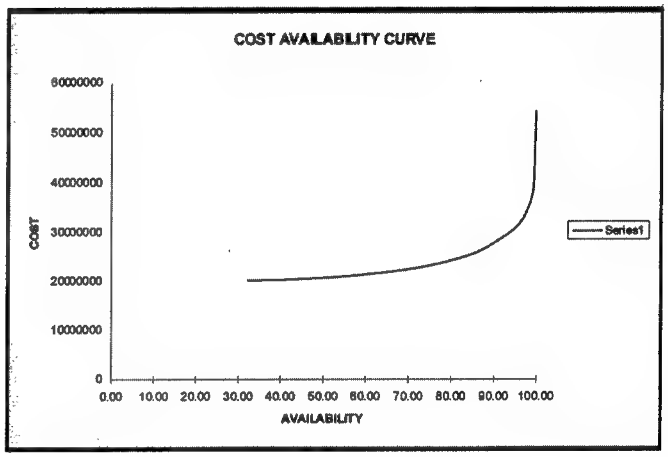

Figure 1. Cost Availability Curve

The peacetime MC rate requirement for all but strategic airlift aircraft is based on a utilization rate, or sorties per aircraft per month, and is calculated somewhat like a unit annual flying plan. Given an annual number of flying days and an expected utilization rate, the number of sorties that need to be flown each day for a squadron sized unit to achieve the utilization rate is calculated. After factoring in historically based non-maintenance attrition factors and break rates in addition to the aircraft turn rate, spare aircraft requirements, and the number of aircraft that will be dedicated to training, a minimum MC rate is calculated. This is the minimum MC rate required to meet the peacetime operational requirement. Added to this minimum peacetime MC rate is the expected percentage of the fleet that will be not mission capable maintenance (NMCM). The sum of adding the peacetime MC rate together with the NMCM rate is the peacetime 1-TNMCS target. If this target is greater than the wartime target, it becomes the target used in the AAM. The strategic airlift aircraft formula is similar, but is based on a training mission factor, an operational aircraft factor, and an aircraft alert factor, instead of a utilization rate.

The next step is to calculate the wartime requirement. The wartime operational requirement currently modeled is two near simultaneous major regional conflicts (MRCs). The

apportionment and planning factors used for determining the wartime targets come from the USAF War Mobilization Plan Volumes 3 and 5. This is an important point because any requirement that is included in the wartime target must be planned for and programmed. Including an unprogrammed requirement in an availability target would not reflect Air Force priorities and would come at the expense of other programmed requirements.

The first input into the WINLAM model is the total USAF inventory for each major weapon system. The source for this data is the Air Force Programming Data System. Next, the number of aircraft apportioned to each of the MRCs is input along with the various planning factors such as sortie rates, turn rates, attrition rates, service times, and massing factors. For strategic airlift aircraft, additional planning factors such as channel distances, on-load and off-load times, ferry distances, and allowable cabin loads are factored into the model. In addition, those forces that are not deployed to the MRCs are programmed to fly a peacetime training program. The WINLAM model uses these inputs to calculate the wartime daily sortie rate requirements for each of the two MRCs and the daily training sortie rate requirements for the non-deployed forces. Using parametric equations, WINLAM models the dynamics of degradation and recovery that occur as the model calculates the daily sortie generation for the entire period of the hostilities or war. The initiation, rate, and ultimate magnitude of the degradation and recovery that takes place is determined by factors such as RSP kit requirements, spare part pipeline times, and the spare parts funding position. The minimum MC rate requirement for a given weapon system is the minimum MC rate that the model can start with and not lose any sorties in either of the two MRCs or the non-deployed training forces theater. The expected percentage of the fleet that will be NMCM is then added to this minimum wartime MC rate. The sum of the wartime MC rate and the NMCM rate is the wartime 1-TNMCS target. The wartime target becomes the target used in the AAM if it is greater than the peacetime target.

Aircraft availability targets usually go up or down every year due to changes in the operational requirement. These changes are primarily driven by increases or decreases in aircraft inventories; changes in the apportionment of forces to any of the wartime theaters; changes in any of the wartime planning factors such as sortie rate, turn rates, or attrition rates; and decreased or increased peacetime utilization rates. Table 1 shows the current availability targets that were used in the March 1997 D041 spare parts computation.

Aircraft	Fiscal Year 2000 Targets (1-TNMCS)
A-10	87.1
F-15	94.2
F-15E	87.3
F-16	88.0
F-117	86.9
C-5	92.3
C-141	95.3
B-1	83.5
B-52	82.0
C-130	88.2
KC-135	89.3
E-3	96.1

Table 1. Availability Targets

Aircraft availability targets are fundamentally different from quality performance measures (QPMs), goals, and command standards because availability targets are based on operational requirements and are applied as the total worldwide weapon system levels. Although different, availability targets are not necessarily incompatible with these other measures. If we look at a weapon system with an MC rate that is above the operational requirement but below the command standard, the command standard could be considered an upper control limit and the operational requirement could be considered the lower control limit. Regardless of the relationship which may exist between availability targets and QPMs, goals, or standards, the operational requirement is the driving force that determines the availability target of a particular weapon system.

While it is true that higher targets may result in additional spares being added to existing inventory, the targets should not be considered either the cause or the fix for most specific spare parts problems. There are a number of reasons why the Air Force has a shortage of specific parts. The AAM targets only help to size the total inventory requirement. If we do not allocate funds to buy or repair assets for the inventory requirement, that would drive a shortage. If real world interruptions delay or disrupt a pipeline, that will cause a parts shortage. A close look at the real causes behind the top mission capable (MICAP) pacing items reveals that factors such as longer than expected repair times, contractor delinquencies, long contract lead times, technical surprises, and funding shortfalls rather than understated requirements, are keeping spare parts from being where they are needed. Increasing AAM targets is not the solution to avoiding funding limitations, process delays, or pipeline delays. In the long run, our collective effort at moving the Air Force from an inventory-based system to a transportation-based system is the most effective way to improve supply support given the current funding environment. In fact, the importance of safety stock in a transportation-based system is greatly diminished as the spare parts pipeline gets shorter and demand variability decreases.

In conclusion, using aircraft availability targets ensures Air Force operational requirements are the driving force in determining aircraft spare part resourcing and inventory needs. This is the fundamental principle on which the entire aircraft availability target process is based upon. Updating availability targets is a disciplined process that ensures the targets track with the most current operational requirements. When operational requirements for a specific weapon system go down from such factors as lower utilization rates, fewer numbers of jets apportioned to the war, or increases in possessed aircraft, one can expect the corresponding availability targets go down. On the other hand, increases in operational requirements for a specific weapon system drive the corresponding availability target higher. The bottom line is to have enough spare parts to accomplish the mission without wasting limited funding on spare parts we do not need. (Lt Col Russell M. Gimmi, HQ USAF/ILSY, DSN 225-6730)

Strategic Planning: Why Do It—and Why Not Do It Better?

Jonathan E. Zall

Introduction

The answer to these questions may be crucial today, especially because of the continually shrinking resources in the Air Force and the Department of Defense (DoD). There are fewer people than ever to devote time to planning activities. However, without a convincing rationale for the importance of strategic planning, competing priorities on senior leaders may divert attention elsewhere. Indeed, a common prevailing view of strategic planning is it must be another management fad that has some value, but will fade away like other fads.

That conclusion may be a mistake. Formal strategic planning has been in active use for most of this century. The private sector has used strategic planning and improved it over the years because of proven results—and profits. In recent years, the public sector has begun to accept and adapt corporate strategic planning processes. In fact, the Government Performance and Results Act of 1993 (GPRA)[1] directs all federal government agencies to develop strategic plans as well as performance plans to describe and measure implementation. Perhaps the most profound effects of a strategic planning process occur when senior leadership actively and visibly supports the strategic planning process—by getting everyone thinking about the future and by enabling the organizational culture to change so people start thinking about how their daily actions relate to the strategic plan.

John M. Bryson, whose strategic planning process for the public sector[2] has been used and modified for Air Force logistics strategic planning since 1990, defines strategic planning as, "... a disciplined effort to produce fundamental decisions and actions that shape and guide what an organization is, what it does, and why it does it." Today, there are many strategic planning processes in use, and there are some common proven elements that warrant serious consideration for logisticians. Strategic planning often fails, however, because of the lack of attention to implementation. This article outlines a strategic planning process approach, the basic elements of which are advocated by public sector strategic planning experts. Special emphasis is given to strategic planning implementation.

Okay, What Is It?

Strategic planning seems to be an elusive concept. Many Air Force and DoD people might say that they know what it is, but those ideas vary quite widely. Confusion of terms and definitions contributes to a lack of agreement on the nature of strategic planning. Depending on the source used, the term "strategic planning" means: (1) big picture or specific critical actions, (2) long term, mid-term or near term, and (3) 20 or more years, 10-20 years, 7 years or less, and even as short as 1 year into the future. For example, the GPRA states that a strategic plan should encompass at least the next five years. The recent Air Force Blue Ribbon Commission on Organizational Evaluations and Rewards recommends up to seven years, and there is a variety of other sources with their own suggested time frames. Rather than becoming hung up in an argument about who is right, this article takes the approach that strategic planning is a *concept*, rather than a specific time frame, which asks a key question: are events driving the organization or vice versa?

What makes strategic plans different from other kinds of plans people develop in the Air Force (and other public sector organizations)? While the range of terms used in strategic planning is bewildering, it is useful to make a basic distinction. Most kinds of planning can be called "incremental." That is, the process looks at what happened in the past and projects out, by extrapolation, where the organization will be in the future—and that becomes the "vision." Incremental planning is, therefore, basically reactive planning. Strategic planning, on the other hand, first envisions *where the organization wants to be*, instead of where it thinks it will be, and then builds a reverse planning staircase back to the present. In this sense, for example, the new Air Force vision, "Global Engagement," which implements *Joint Vision 2010*, is truly "strategic" in nature.[3] Similarly, the Air Force logistics community has been making process improvements to its strategic plan since its inception in 1988. However, in contrast, most kinds of incremental plans fail to have lasting power because they do not make clear ties to the budget process. Strategic planning aims at establishing such ties by identifying what needs to be funded now, and in succeeding years, in order to reach the strategic plan vision.

This distinction between incremental and strategic planning, shown in Figure 1, is *crucial*; in strategic planning, instead of muddling into the future, the organization aggressively decides where it wants to be and then steps back into the present and decides what needs to be done to reach the desired vision—not a vision they are being driven to.

In strategic planning, the organization cannot try to plan for everything, nor can it control all the events regarding the future. Instead, the focus is on the most important issues to be addressed in order for the future vision to be realized. The strategic plan[4] is intended to be the framework setting the course for the future as well as for improving how the organization does things today. The plan is a flexible, living document, which in one sense is never really finished. More important than the plan itself is the strategic planning process, which should, if done right, engage all levels of the organization in encouraging creative and innovative inputs.

When this sort of culture change takes place, the strategic planning process becomes the framework for obtaining:

- An agreed upon vision of the future. All members of the organization should know where the organization wants to be as a whole.

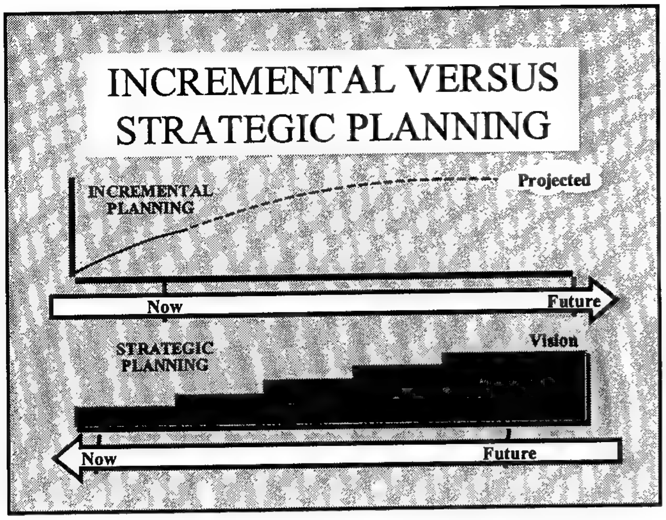

Figure 1. Incremental Versus Strategic Planning

- A set of clearly identified actions for the future. The organization should have an understanding, at all levels, of what needs to be accomplished to reach the vision.
- The means to tie future requirements to the programming process.
- The support of senior leadership as well as the logic for making logistics inputs into the budget process.
- The means to measure plans for the future. The organization should be able to identify when progress has been made in reaching the vision.
- An improved process for making daily decisions.

There are many strategic planning processes in use today by government, nonprofit, and commercial enterprises. Many are very similar in their approach. Some are more appropriate to government and nonprofit organizations, while other processes are designed specifically more for private sector organizations where maximization of profit is the ultimate goal. In the latter case, some public sector organizations have tried to force fit an approach that would not work for them.

Most strategic planning processes for the public sector reasonably align with the four-phase approach shown below in Figure 2.[5]

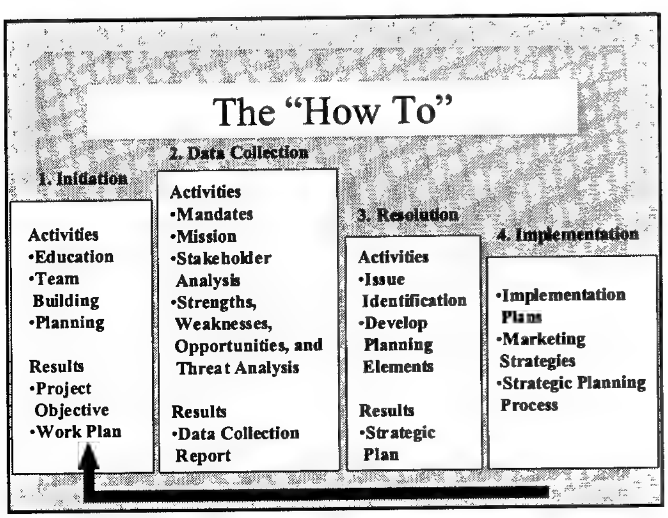

Figure 2. Basic Phases of Public Sector Strategic Planning

Project Initiation

The purpose of the first phase, Project Initiation, is to "organize for success" and ensure the strategic planning process begins in a mutually supportive environment. During this phase, the organization selects a strategic planning process and discusses it among personnel to ensure everyone understands the process and believes it is right for the organization. This includes defining what strategic planning is and what to expect from it. The organization will also identify key stakeholders and decision makers along with the individuals that can contribute most effectively to the strategic planning development team. The strategic planning team forms the nucleus of the strategic planning effort, and the team needs to familiarize themselves with the strategic planning process. Once the organization has properly performed the Project Initiation Phase, the individuals responsible for the creation of the strategic plan will know who they are, understand the process and the expected results, and fully support the development of the plan. By creating this team atmosphere, the organization ensures the plan accurately reflects the values and decisions of the organization and gives everyone a sense of ownership of the strategic plan.

Data Collection

The Data Collection Phase provides the basis for identifying the true strategic issues that face the organization. Data collection is critical in determining where the organization is today. It is also a key credibility factor for the project and is often a catalyst that results in buy-in from stakeholders, clients, staff, and management. During the Data Collection Phase, the strategic planning team gathers information on the organization's mandates, mission, internal environment, external environment, and any other source that would help the team better understand where the organization is today. All information collected on the status of the organization, provides a unique contribution to understanding the organization's strategic issues. At the conclusion of the Data Collection Phase, the team should have a firm understanding of the current state of the organization and where the organization wants to be in the future.

Resolution

The objective of the Resolution Phase is to develop a strategic plan based on the information gathered during Data Collection. The organization develops guidelines for achieving their desired state in this phase. To develop these guidelines, the strategic planning team needs to determine the difference between where the organization is today and where it wants to be in the future. By understanding this difference, the team will be able to capitalize on the information gathered during previous activities to determine what strategic issues could prevent the organization from achieving their desired state. This information will guide the team in developing strategies to obtain the desired organization while managing any potential issues. The strategic planning team reviews and prioritizes the developed strategies according to their importance to the organization. At the conclusion of this phase, the organization should have developed a strategic plan that will guide them into the desired future.

The Resolution Phase paves the path for the organization to achieve its vision of the organization in the future. This path started from the defined vision of the future and worked back to the current environment. Although there now is a path for the organization to follow, it still must work hard to implement the developed strategic plan. The implementation of the strategic plan is as important as the development of the plan. This is why the next phase, Implementation, is critical to the overall success of a strategic plan—and why the remainder of this article concentrates on this often neglected phase.

Implementation

The final phase in the development of a successful strategic planning process is the implementation[6] of the strategic plan. Even if the organization develops a model strategic plan in the first three phases, those efforts are useless unless the plan is implemented. The Implementation Phase brings the strategic plan to life. The critical importance of the Implementation Phase is in its objective: *Making the Plan Make a Difference.* To realize the benefits of strategic planning, an organization must learn to use their strategic plan to guide their everyday decisions. Although the concept of managing within a framework of an explicit, agreed upon set of strategies appears simple in concept, a number of common barriers to implementation must be overcome to make the strategic planning process successful:

Accountability for Implementation May Be Lacking. Without a strong implementation process, the strategic plan becomes another document sitting on the shelf collecting dust. One key to successful implementation is assigning specific responsibilities for the implementation of the action items in the strategic plan. Someone must be directly responsible for each item. Secondly, a mechanism must be in place to monitor progress against the plan. This mechanism should include some form of senior management review. Without direct senior management oversight of the process, implementation of the strategic plan has the potential to fall to the bottom of the action officer's queue.

Strategies May Not Be Well Defined. Individual strategies may be ambiguous. The challenge becomes how to bridge communication gaps so the intent of the strategy is obvious to all. People cannot implement what they do not understand, so it is worth investing the time to carefully articulate each strategy—both in writing and verbally—to the organization as a whole, not just to a few select individuals.

Personnel May Have Little Comprehension of Their Role in Strategy Implementation. Poorly defined strategies may be accompanied by poorly defined roles and responsibilities for their implementation. To effectively execute strategy employees must have a clear understanding of what is expected of them—including clear guidelines about taskings, priorities, time frames, and accountability.

Strategic Plans Are Rarely Linked to Rewards. In many organizations, the linkage between strategic planning and the compensation system is either weak or nonexistent. Such linkages are less easy to develop and implement in the public sector. However, forms of compensation, other than financial, are possible, such as special recognition, documentation in performance reports, etc.

Planning Process May Lack Follow-Up. One common problem in the public sector is once the organization has a strategic planning process (and a plan) in place, people tend to return to the present day alligators—"business as usual." Even well-intentioned managers can quickly lose focus on the strategic plan and become distracted by the daily pressures of their duties. The implementation process then becomes characterized by ineffective monitoring and a lack of individual accountability. The predictable result: the strategic plan sits on the shelf and yields little or no benefit to the organization.

Organizations Are Characterized and Influenced by Hierarchical, Fragmented, or Functional Structures. The strategic planning function in the public sector often reports at a relatively low level in the organization and is buried within one of its "functional towers." This relatively low positioning inhibits direct communication with the organization's strategic managers—a vital link needed for strategic planning to succeed. Below the executive level, organizational dynamics, including rivalry for resources and other forms of "turf wars," may inhibit the effectiveness of the strategic planning group. In organizations that are functionally oriented—whether in structure, skills, or behavior—strategic thinking is often inhibited and partisan perspectives are reinforced. Different organizations are trying to address these planning barriers in different ways—some through structural changes such as process teams while others are trying to develop new cultures and behaviors.

The Relationship Between Strategic Planning and the Budget Process Is Weak or Nonexistent. No matter how good an organization believes its strategic plan and planning process to be, there must be ties established to the budget process. That is, in order to reach the vision of the future (see Figure 1), certain actions should be generated in the present to ensure necessary funding. This process is intimately tied to implementation of the strategic plan. Without ties to the budget process, the right priorities for the future may be neglected.

The budgeting process plays an important role in strategic planning. For strategic planning to be effective, goals, objectives, and strategies should first be developed independently of financial constraints and the end results tied to the budget. By associating strategic priorities to financial resources, the strategic plan becomes a reality and a framework for current decision making. Without the necessary ties to the budget process, the strategic plan will not be implemented well, or at all.

Participants May Become Focused on Paper Rather Than on Action. The end product of the strategic planning process is often a huge document filled with reams of analysis and meticulous details that are frequently not read, acted on, or used. This lack of focus and clarity is particularly harmful because preparation of the document begins to override the development of good strategy. The resulting document becomes, in itself, a barrier to implementation.

There May Be a Lack of Leadership Commitment, Participation, and Endorsement. For strategic planning to be effective, there must be commitment and involvement from the very top of the organization. This is the only way to overcome such barriers as rivalry among departments or individuals, resistance to change, resource requirements, and time and scheduling constraints. Major benefits of strategic planning come

from the dialog and interaction of management and staff. The planning process should improve communication, build a cross-functional perspective, and develop a consensus for a particular organizational direction. These benefits can be realized if senior management is actively involved and drives the planning process.

There May Be a Lack of Buy-In by the People Who Ultimately Implement the Plan. No matter how good a plan is, it can not succeed without being embraced by the organization. Senior management buy-in is a must—without it, no one in the organization will care about the plan. A process that allows for representation by members of the organization outside of the senior leadership will allow for a greater level of buy-in. This is not to say that strategic planning no longer becomes the purview of senior leadership—rather that staff participation during development, and the resulting feelings of ownership will yield significant dividends during implementation.

Conclusion

Strategic planning has the potential for providing real value-added improvements for how we plan for the future and operate today. However, there seems to be little middle ground between whether the plan actually begins to control organizational culture or whether the plan sits on the shelf after publication. The picture contained in the current literature on public sector strategic planning portrays a common result: large numbers of man-hours (even changes to organizations) to develop a strategic plan that never really gets implemented. Attention to implementation makes a crucial difference in whether or not strategic planning will successfully cause the future vision to be reached—regardless of how far out your plan goes into that future.

If you are about to begin developing or revising your strategic planning process, consider taking several actions[7] especially to strengthen the Implementation Phase:

1. ***Consciously and deliberately plan and manage implementation like the rest of the phases of strategic planning.***
2. ***Develop strategies for buy-in early in the planning process.***
3. ***Require action plans to implement your plan but keep the format simple and flexible.*** Action plans implement strategic plan strategies and should include such areas as roles and responsibilities, specific actions and expected results, schedules and milestones, resource requirements, performance measurements, and review and accountability procedures. To successfully implement this step, the organization should provide support in terms of sponsors, time, and money.
4. ***Declare victory with less complex initiatives first, and use these "victories" to motivate others in the organization and get the ball rolling.***
5. ***Build in the resources to ensure successful implementation.*** This means people, time, money, administrative services, etc. Commitment of senior leadership leads the way.
6. ***Link new strategies with ongoing operations in effective ways.*** Address transition requirements, if needed.
7. ***Look for ways to "compensate" people for successes.*** Find creative ways to reward people for their hard work and success in implementing their initiatives. While monetary rewards may be possible with civilians, other forms of reward and motivation are available for all. Consider tying performance reports and advancement with effective implementation of the strategic planning process.
8. ***As much as possible, fill leadership and strategic planning positions with people committed to the change effort.***
9. ***Build in clear support for action officers.*** The majority of strategic plan strategies will likely involve complexities, as well as internal and external constraints, out of the control of the action officer. The action officers need to know that senior leadership is in partnership with them to make implementation a reality.
10. ***Periodically evaluate implementation of your strategic plan and the strategic planning process as a whole.***

For Further Reading:

1. Blackerby, Philip, *Strategic Planning: Start Here—How to Write a Plan-to-Plan*, Performance Strategies Inc., Internet homepage, http://www.perfstrat.com.
2. Bryson, John M., *Strategic Planning for Public and Nonprofit Organizations*, San Francisco: Jossey-Bass Inc., 1995.
3. Goodstein, Leonard D., Timothy M. Nolan, and William J. Pfeiffer, *Applied Strategic Planning, A Comprehensive Guide*, New York: McGraw-Hill Inc., 1993.
4. *The Government Performance and Results Act, Public Law 103-62 [S-20]*, 3 Aug 93.
5. Hill, Charles W. L., and Gareth R. Jones, *Strategic Management, An Integrated Approach*, 2d ed, Boston: Houghton Mifflin Co., 1992.
6. Kotler, Philip, *Marketing Management—Analysis, Planning, Implementation, and Control*, 8th ed, Upper Saddle River, NJ: Prentice Hall, 1994.

Notes

1. *The Government Performance and Results Act, Public Law 103-62 [S-20]*, 3 Aug 93.
2. Bryson, John M., *Strategic Planning for Public and Nonprofit Organizations*, San Francisco: Jossey-Bass Inc., 1995, pp. 4-5.
3. Chairman of the Joint Chiefs of Staff, *Joint Vision 2010*, Washington DC: U.S. Government Printing Office, Sep 96.
4. For what I am calling a single "strategic plan," many public sector organizations may use several kinds of plans, one of which may be called their strategic plan.
5. See the references in For Further Reading for some current comparative approaches.
6. See Bryson, especially pp. 166-187. In his most recent edition, he implicitly acknowledges he did not previously pay sufficient attention to implementation.
7. These actions were distilled from the references, especially where there was apparent agreement.

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CAREER AND PERSONNEL INFORMATION

Geographic Location Code (GEOLOC) for Logistics Civilian Career Enhancement Program (LCCEP) Positions

A GEOLOC is a six character alphanumeric code that indicates the following about a position: geographic location, grade, supervisory level, and the career program it falls under.

The first two characters indicate the geographic location and the geographic area of the position. You may register for the geographic location (a specific location), the geographic area (the same type of position at any Air Force installation within a geographic area), or worldwide (the same type of position anywhere in the world a position might exist).

The third character indicates the lowest grade and the supervisory level you are willing to accept. You will always be considered for the grade indicated and each higher grade, if the time-in-grade eligibility has been met for the requisite grade of the position being filled. By selecting the proper GEOLOC, you may indicate an interest in supervisory or non-supervisory positions, or both.

Characters four through six reflect the respective Career Program Personal Availability Code. The fourth character indicates the career program while the fifth and sixth characters indicate the occupation of the position. In the case of LCCEP covered positions, the forth character will always be "N." The fifth and sixth characters represent the occupational series and position title.

Not understanding the structure of the GEOLOC code can have significant negative results. The following are some examples of errors that have impacted registrant careers:

- Not properly registering in LCCEP or registration dropped from the computer.
  Result: Not considered for any LCCEP position. While failure to register can be blamed on the employee, certain personnel actions will cause registration to drop from the computer. The most common of these pertain to the personnel actions such as promotion, reassignment, and permanent change-of-station (PCS).
  Solution: Review GEOLOC codes you are registered for at least annually or after any of the above personnel actions.
- Not registering for current duty location.
  Result: Not considered for any LCCEP position at the present duty location.
  Solution: Update GEOLOC codes to include present duty location.
- Registered for non-supervisory positions only.
  Result: Consideration is limited to non-supervisory positions only, regardless of GEOLOC registration.
  Solution: Make certain the third character of a GEOLOC reflects the supervisory level desired.
- Registered for GEOLOC codes for occupational series of current position only.
  Result: Consideration is limited to positions only in your current occupational series.
  Solution: Review the last two characters of the GEOLOC and ensure they reflect the occupational series you want. If "ZZ" is used as the last two characters, you will be considered for all series in which you are qualified.
- Registered in multiple Civilian Career Programs but GEOLOC codes indicate a desire to be considered for positions covered by only one program.
  Result: Consideration will be limited to the positions covered by the one career program.
  Solution: Review fourth character of the GEOLOC code to ensure it reflects the program(s) you want. An "N" as the forth character indicates a desire for LCCEP consideration only. A "W" in the forth place indicates a desire for consideration for all programs you are registered for.

Using GEOLOC codes for geographic areas and worldwide is an excellent way to get wide consideration with the input of a minimum number of GEOLOC codes, but it does have some pitfalls. Area GEOLOC codes include all bases within the area selected. If you are not interested in relocating to any one of the bases within the area, then you must enter the code for each base where you are willing to relocate. The worldwide code should only be used if you are willing to relocate to any place in the world. A complete list of GEOLOC codes is available at your servicing Civilian Personnel Flight (CPF).

If several GEOLOC codes are listed for a location, you may register for each. If you wish consideration for any position in any organization at a given location, register using the "All Organization" code. If you use an area code, there is no need to list locations covered within the area code. If you use the worldwide code, there is no need to list area codes or location codes. An area code will override all location codes contained within the area code and the worldwide code will override all other codes.

Do not select GEOLOC codes for locations where you are unwilling to relocate. There is a six-month non-referral penalty for declining consideration and a 12-month non-referral penalty for declining selection. While under a penalty you will not be referred for any LCCEP covered position, including those at your present duty location. Also, the fact that a base is closing is not

(Continued on bottom of page 39)

A Proposed Organizational Template for the Future

Technical Sergeant David R. Wimsatt, USAF

Editor's Note: This article presents one approach, from a macro perspective, to realigning wing and base organizational structures to meet the demands of the 21st century. It is meant to stimulate thought, not discuss in detail the myriad of micro-level changes necessary to implement the approach suggested.

Introduction

As the Air Force moves toward *Joint Vision 2010,* an excellent opportunity to evaluate organizational structure and functional alignment presents itself. (1) Now is the time to evaluate how organizational structures are applied to achieve mission objectives in the logistics community, to develop a framework to provide a lean logistics signature at the base level, and to provide a structure capable of capitalizing on and maximizing lean logistics efforts. Logistics support in 2010 will exist in an environment requiring light, fast, and responsive logistics operations. Logistics operations will focus on weapons systems support, but will rely on privatization and outsourcing to provide general, non-mobile force support. This article focuses on one approach to streamlining and at the same time enhancing logistic support of the wing and base level. The approach discussed eliminates base level supply, transportation, and finance functions, as they currently exist. The result is a wing with fewer military manning requirements, a more responsive structure, and a leaner logistics footprint.

The Problem

Currently, the wing and base organizational structures in place are not efficient, either operationally, or fiscally, to prepare for and engage in expected future conflicts or military operations. The logistics organizational model employed at base and wing levels was designed in response to expected Cold War operations and demands. The organizational structure created was built on the assumption future wars would be long interactions between large forces. Conflicts with Grenada, Panama, and most recently Iraq, have demonstrated the fallacy of this assumption. It appears likely that future conflicts will involve advanced technology to support and enhance troop operations and will not be lengthy in duration. The current wing and base organizational structure also suffers from two additional deficiencies. First, when the organizational template evolved, the technology available did not allow for robust and rapid response computer and data systems. Second, the organizational template was not designed to facilitate integration of civilian or commercial support outsourcing and privatization.

Background

To better understand the nature of the problems and the reasoning behind the reorganization approach proposed, it is beneficial to examine the history of the current logistics structure. To gain a proper perspective on how current logistics templates evolved it is necessary to go back approximately 50 years. At that time, the Cold War threatened to become a conflict involving national mobilization and the use of weapons of mass destruction. Building upon the lessons learned from WWI, WWII, and the Korean Conflict, the Air Force, for years, postured to move large numbers of people, equipment, and combat power to a battle zone.

Early automation systems were large, costly, and by nature designed to support a centralized organization specializing in specific professions. This "new" technology encouraged the development of large specialized squadrons such as supply, finance, and transportation. When introduced into the logistics community at base level, the costs associated with large main frame systems and the intensive training required to operate them promoted the development of a separate and segmented logistics complex. The standard base supply system, finance, and transportation became centralized functions. These were large squadrons that produced customer products in support of customers believed to have generally common management data requirements.

The development and deployment within the Air Force community of personal computer (PC) based management systems and a focus upon Total Quality Management has changed the way customers view logisticians. It created customer groups with high expectations of the logistics support they receive. In today's Air Force, customers no longer accept being viewed as a large homogenous group requiring similar support and output from the logistics complex.

The trend toward lean, responsive, customized logistics began 15 to 20 years ago and was pioneered in the Tactical Air Command (TAC). TAC developed a forward-integrated support package termed the Combat Oriented Supply Organization (COSO). The COSO concept moved key functions and material closer to flight line operations and maintenance areas and emphasis was placed on a fast responsive unit focused on aircraft support. COSO was so successful that virtually every other command has since adopted some variation of the COSO template. Recent manpower reductions and economic pressures have encouraged commands to identify and evaluate ways of streamlining their rapid response capabilities.

The objective wing is the most recent evolution in the effort to make the Air Force a rapid response military structure capable of maintaining a sustained force presence in any theater of operations. The heart of the approach originated with the understanding that the Air Force mission was to "fly and fight." (The current mission of the Air Force is to defend the United States through the exploitation of air and space.) All base organizations have their origin and purpose in that simple

objective. However, a review of the major functions within the typical base structure gives some indication as to the redundancy and loss of focus on aircraft availability to fly and fight (Figure 1). Fully three quarters of a base's activities are support in nature.

The Current Condition

Functionally, wings are comprised of two diverse customer bases—weapons support customers (WSCs) and personnel support customers (PSCs). WSCs are those maintainers and operators that directly contribute to a weapons system's availability and employability. The PSC group consists of personnel whose duties support the overall medical, financial, and personnel support functions. Taking these two customer groups as a baseline, some immediate distinctions can be made as to their logistics needs. Units in the PSC group make most of their expenditures for General Supply Agency (GSA) type items such as common use office equipment, local purchase (LP) retail store supplies, such as paper, pens, and office consumables, and individual equipment unit (IEU) items such as cold weather gear, hats, gloves, etc. These items are supported from the Standard Base Supply System (SBSS) and require the expenditure of resources in the form of manpower, money, and storage space.

The WSC group makes most of their expenditures for weapons system support items. This is in the form of aviation fuel (AVPOL), depot level reparables (DLRs), weapon system consumables (XB3 bench stock items/XF3 field level repair or condemn items), and a relatively small expenditure for GSA, LP store, and IEU. Similarly, the resources required for the WSC group is much more complex, involving more manpower, money, and space.

Proposed Organizational Template

One solution to the problem and limitations associated with current organizational structure is an organizational template that creates a total logistics program by integrating the traditional transportation, supply systems (SBSS), finance, and maintenance support functions. This article offers a platform to restructure and rethink the organizational templates currently utilized throughout the Air Force. The result is a model that unites the various complementary specialty skills required to support and manage weapons systems availability (Figure 2).

To evaluate the current templates the following questions were asked about functional units within each organizational structure.

1. Does the function support WSC, PSC, or both customer groups?
2. Is it essential that the function is deployed with the unit, or can it be provided from a home station?
3. What higher function does it support? (Logistics, Operations, Medical, Personnel Support)
4. Can the function be more effectively managed and provide greater efficiency by uniting the function with other functional areas?

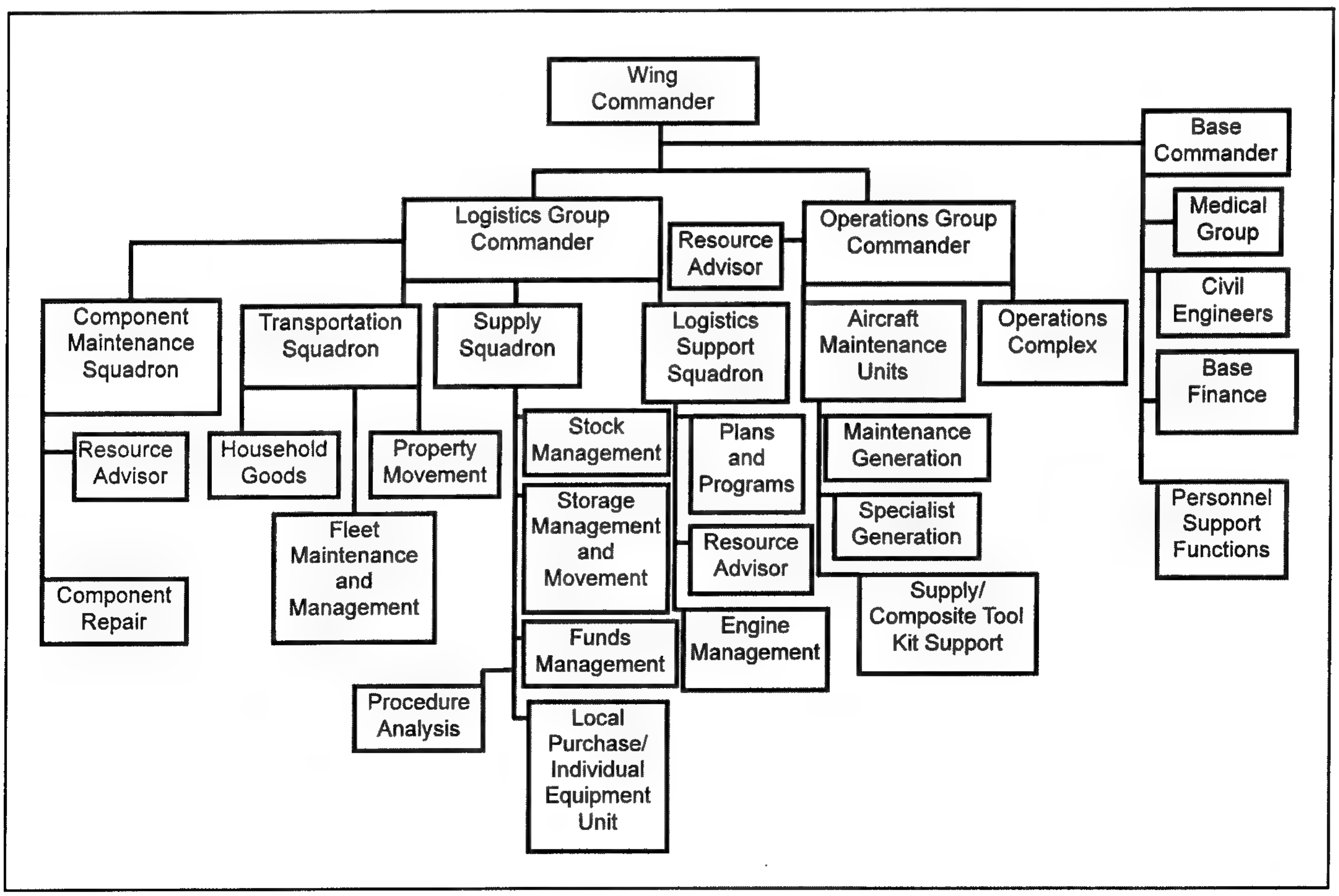

Figure 1. General Functional Duties Chart

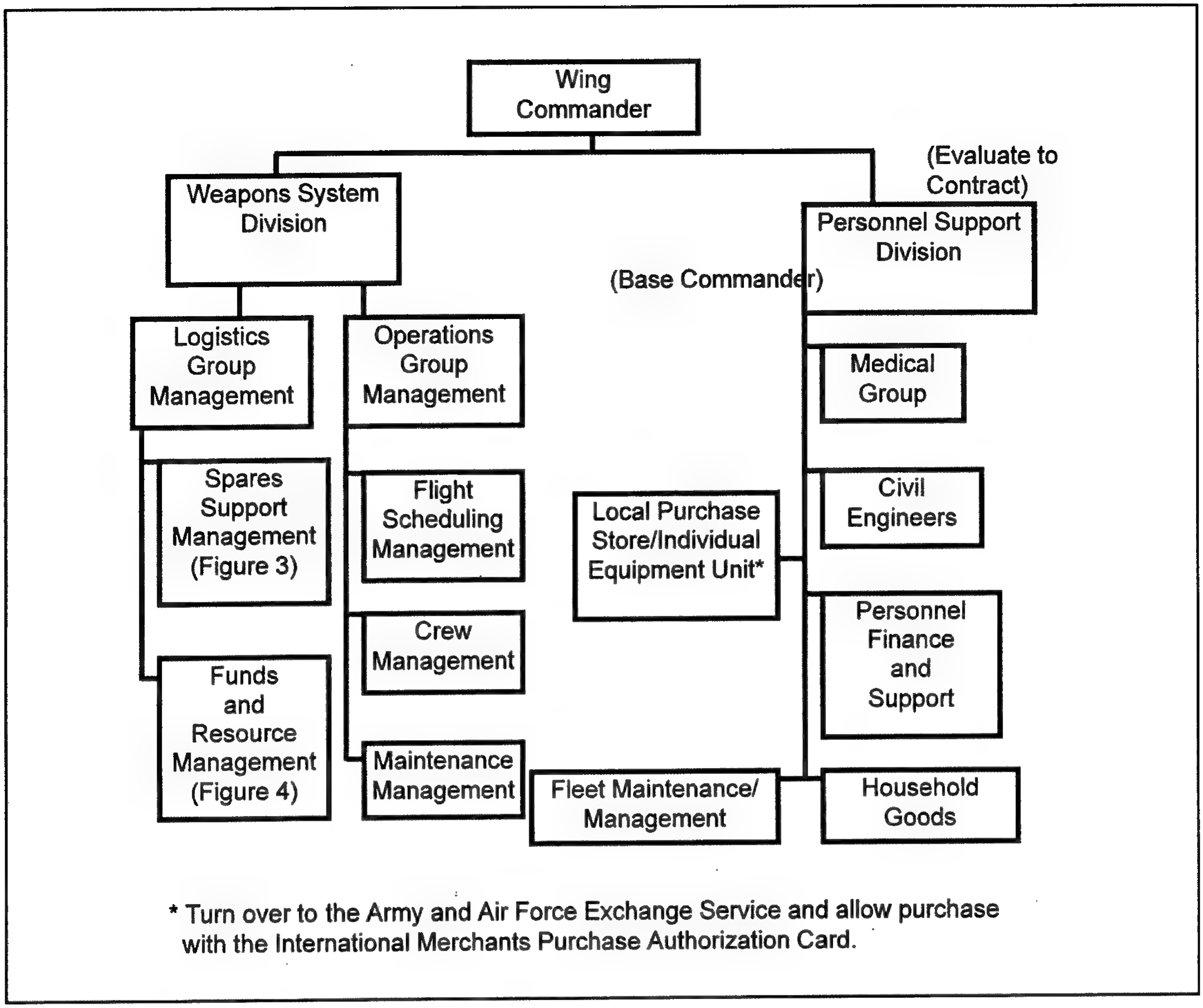

Figure 2. Proposed Functional Group Wing Alignment

Recommended Restructuring

This proposal dismantles the Supply Squadron, Transportation Squadron, and Finance function and reconfigures WSC support functions into a Spares Support Management Squadron (Figure 3, following page).

The Transportation Squadron's vehicle fleet management and maintenance is moved to a commercial contractor. The transportation management shipping and receiving section is moved into the Spares Support Management Squadron for shipment and receipt of WSC property. All non-WSC property movement is redirected through privatization and outsourcing to a contractor tasked to move household and general use property to and from the base. A small combat transportation element will exist either in the Aerial Delivery Squadron, or as a mobility function within the Spares Support Squadron. The function of this element will be to provide forward-deployed locations with a small fleet management and maintenance facility. It will also provide transport coordination to deploy a unit. The result is the wing remains capable of organizing and coordinating its own mobility missions.

The Base Supply Local Purchase Store, Tool Issue, and Individual Equipment Units, formerly aligned in base supply could logically be transferred to the Army and Air Force Exchange Service (AAFES). The introduction of the International Merchants Purchase Authorization Card (IMPAC) has provided an opportunity to allow operations and maintenance (O&M) funds to be managed in new and more effective ways. This development eliminates the need for base supply to maintain retail type store items and personal issue tool and uniform items. AAFES is better suited to competitively procure, stock, and manage these type items. This is equally true for all GSA cataloged items. If GSA is the best price source for these items, then AAFES should be allowed to procure them from GSA for resale to government agencies using the IMPAC card. This has the added benefit of promoting a competitive environment within GSA. Competition should result in a more efficiently managed GSA.

Stock Control, Requirements, Research, MICAP, Bench Stock and Mobile Support Readiness Packages (MSRP) will be moved into the Spares Support Squadron. Only WSC assets will be

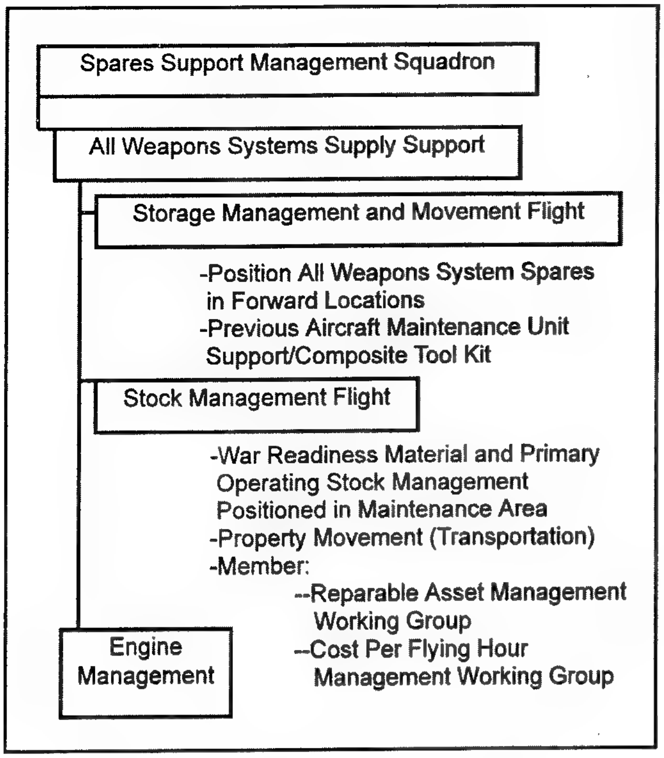

Figure 3. Spares Support Management Squadron

stocked and managed by this squadron. All weapons system spares should be moved as near to the maintenance complex as possible. The previously aligned Aircraft Maintenance Unit Support and Composite Tool Kit (CTK) section would function within this squadron. Specific transportation duties of shipping, receiving, and mobilizing would be in the Storage Management and Movement Flight (Figure 3). The emphasis is to integrate logistics career fields specifically to meet weapons system requirements. Ideally, this flight would be 100% worldwide mobility qualified in support of the weapon systems in the wing. However, only the MRSP and CTK/ Material Control sections specifically need to be deployable. The other sections could be considered for privatization and outsourcing. If contracted, the contractor should function within the squadron environment.

Stock Management is the second flight within the Spares Support Squadron (Figure 3). This flight would manage the stock position maintained at the base for all weapons systems Primary Operating Stock (POS) and War Readiness Material (WRM). The Stock Management Flight would track, manage, and evaluate the transportation pipeline. Additionally, Engine Management would be aligned into this squadron because of the weapons system specific nature of the assets that are managed. This entire element could be evaluated for privatization and outsourcing.

Base Finance is divided into WSC support and PSC support. WSC support becomes the Funds and Resource Management Squadron (Figure 4). PSC financial functions are rolled into a Personnel Finance and Support Squadron. Personnel Finance and Support Squadron will largely be contracted through privatization and outsourcing initiatives.

The Funds and Resource Management Squadron would be the responsible unit for tracking and managing all weapons systems fund requirements. This would include the previously aligned Stock Funds Manager. The focus should be on a total stock position rather than the warehouse stockage position that is currently emphasized by demand rate data, and warehouse and issue effectiveness rates currently calculated by the SBSS. Depot level reparables (XD2), consumable (XB3), and base level reparable (XF3) assets maintained in the Maintenance Management Squadron should be considered when determining the total stockage funding requirements for a wing. This is currently done somewhat within wings now. However, the compartmentalization of resource advisors, wing funds manager, and the SBSS stock fund manager allow for poor cross flow of information. This tends to result in a myopic view of funds management. Each section focuses on micro-system management rather than total stock/funds utilization. The focus and functions of this squadron should be to ensure the wing gains the maximum value from every dollar spent.

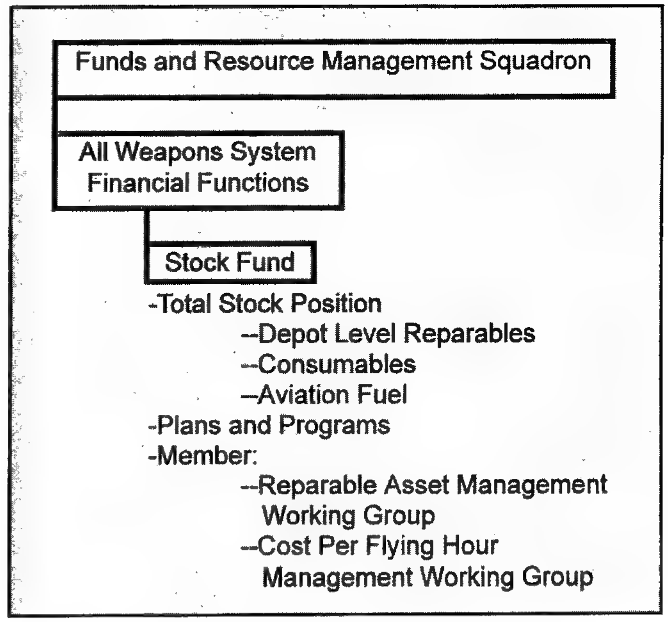

Figure 4. Funds and Resource Management Squadron

Two important working groups are proposed. The Reparable Asset Management Working Group and the Cost Per Flying Hour Working Group. The Repairable Asset Management Working Group should be chartered to review procedures and management tools that enable a wing commander to reduce the cost of repairing and replacing spares on the aircraft and in the supply system. It would be responsible for monitoring the total wing depot level reparable (DLR) float and the inventory turnover both through the Maintenance complex and the Spares Support Management Squadron. In private industry, inventory turnover rates and production line throughput rates have long been considered critical management data for efficient plant operations. The Air Force can greatly improve the budget position of its wings through similar managerial accounting practices. This working group should consist of senior leadership from the Funds Management and Resources Squadron and the Spares Support Management Squadron. Additionally, senior and midlevel enlisted members should be encouraged to stay active with this working group. Training in management accounting, inventory turnover rates, and production throughput should be provided to all squadron commanders and senior leadership.

The Cost Per Flying Hour Working Group would be chartered to constantly review the wing's costs and develop parameters to ensure full value is gained from every dollar spent. Specifically, this group should review and make changes as needed to the total stockage position of inventory in the wing. This includes DLRs, Consumables, and AVPOL. This group should be chaired by the Funds and Resource Management Squadron Commander and report directly to the Wing Commander. Its members should be from every organization on the base. Each organization should be prepared to account for their expenditures and demonstrate how they contribute to the wing's mission. Annual symposiums would convene for each major weapons system identified in a command. The symposiums would allow flying hour working group members from various bases to gather and share ideas and review programs.

Conclusion

This organizational structure outlined in this article is aimed at stimulating thought about how organizations are aligned to meet and respond to a rapidly changing mission and force structure. Obviously, this is a radical restructuring of the wing and base organization. Understandably, this article does not deal with all functional areas or every task. Rather, it treats the organization in the macro-functional arena and does not try to examine necessary micro-level change necessary for the proposed structure to become a reality. This would of course have to be done.

References

1. Chairman of the Joint Chiefs of Staff, *Joint Vision 2010,* Washington DC: U.S. Government Printing Office, Sep 96.

Technical Sergeant Wimsatt is presently the Noncommissioned Officer in Charge of Logistics Analysis at the 58th Logistical Support Squadron, Kirtland AFB, New Mexico.

(**Career and Personnel Information** continued from page 34)

justification for declining consideration or selection at a closing base. LCCEP registrants who have selected GEOLOC codes for a closing base and then decline consideration or selection prevent other registrants from being referred.

The preceding information and examples are not all-inclusive but serve as a guide for you to conduct a review of your GEOLOC codes and understand how to select accurate codes. Changes to GEOLOC codes should be submitted to the servicing CPF on Air Force Form 2675, Civilian Career Program Registration and Personal Availability. The CPF has the forms and a list of all the codes available to assist you in selecting the GEOLOC codes. It may take up to 45 days for additions and changes to GEOLOC codes to become available for use in certificate processing. For this reason, it is best to ensure your GEOLOC codes reflect your true availability rather than attempt to adjust your GEOLOC codes each time you get word of a vacancy. Questions concerning your current LCCEP GEOLOC codes may also be directed to the Air Force Personnel Center (AFPC) Call Center at DSN 487-7849, 1-800-558-1404, or to the LCCEP PALACE Team at DSN 487-4087.

AFPC On-Line

If you get the answering machine when you call the Logistics Officer Assignment Team at the Air Force Personnel Center (AFPC), don't be surprised—AFPC gets over 100,000 assignment related calls each month. Looking for a better way to do business with AFPC? Try the AFPC home page on the Internet at http://www.afpc.af.mil. The home page offers many of the services AFPC provides via phone, and you can reach it 24 hours a day—no busy signals, no voice mail.

The most frequent interaction the assignment team has with logistics officers is processing requests to volunteer for jobs. The Internet provides full access to all advertised positions and the option for officers to volunteer for job openings on-line. You can even add pertinent comments to your volunteer statement such as "I am within one exam of completing ACSC." If you use a government computer to access the home page you can use the most recent enhancement know as the Assignment Management System (AMS.) AMS allows officers to review their own personnel data such as duty history, decorations, education level, and important dates like date of rank, short tour return date, etc. (there is plenty more.) AMS also gives officers and commanders the ability to provide career comments to AFPC on-line—something like the old Air Force Form 90s, the Officer Career Development Worksheet. For instance, you may want to let AFPC know you would like a staff tour next. Your commander can make recommendations as well. When appropriate AFPC will use these comments for making assignment decisions, and at times, forward them to potential hiring authorities.

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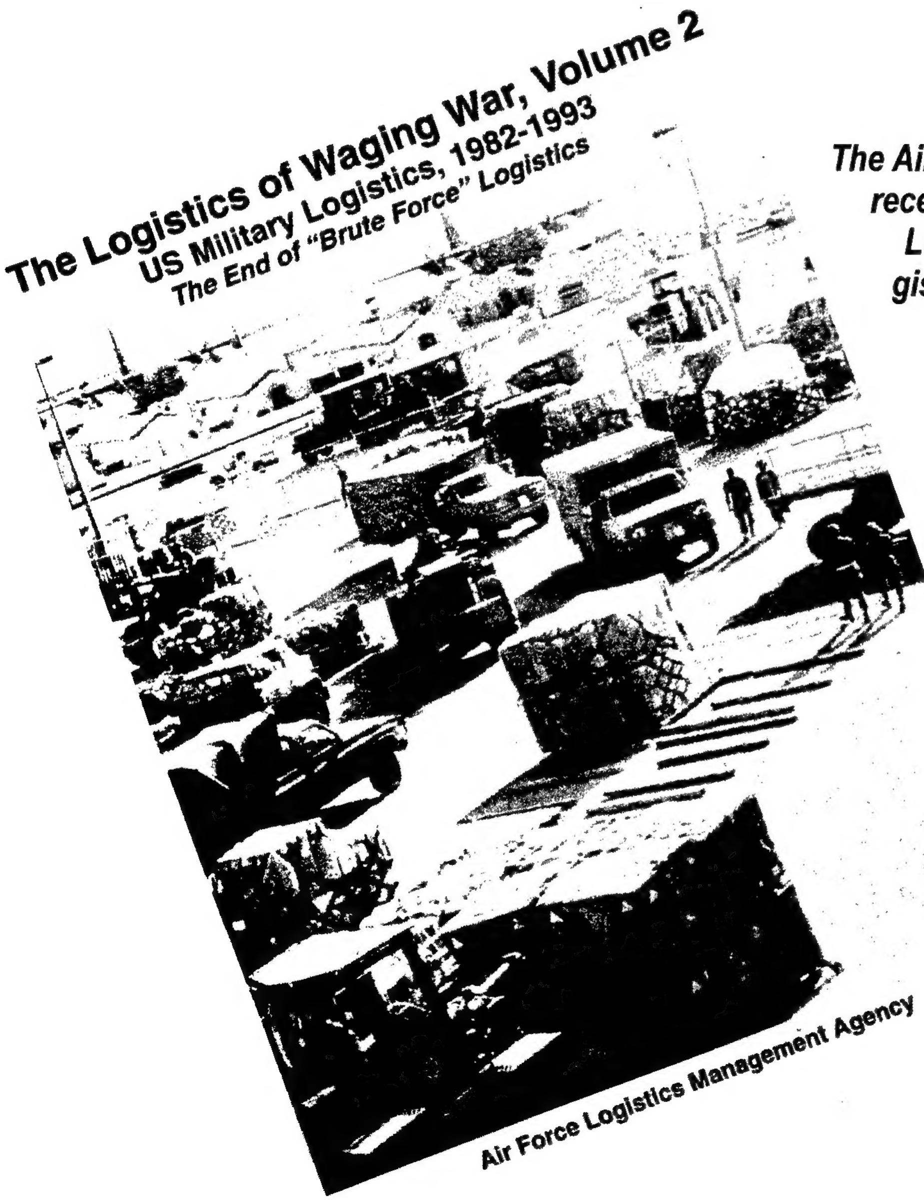

The Air Force Logistics Management Agency recently published the latest edition of the Logistics of Waging War series, The Logistics of Waging War, Volume 2. Chronicling logistics efforts and operations from 1982- 1993, Volume 2 examines the final chapters of what has been aptly called the era of "brute force logistics." The Agency distributed this fine monograph to all major Professional Military Education schools and will soon make it available through the Air Force PDO system and the World Wide Web.